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Report of the Principal of the School of Horticulture ... 1899

Trenching and subsoiling for American vines / R. Dubois and W.P. Wilkinson (1901)

DIRECTOR BOTANIC GARDENS MELBOURNE

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Botanic

ANNUAL REPORT.

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DEPARTMENT OF AGRICULTURE, VICTORIA.

1899

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PREFACE.

The fact that a necessity has arisen for the continuance of publication of a Year-Book of the Victorian Department of Agriculture, and that its editor finds himself somewhat embarrassed by a superabundance of material wherewith to fill its pages, betokens alike the importance already assumed by the great industry to which it relates, and the magnitude of the operations embraced by the Department.

These operations are so little known to the general public that a feeling of surprise will probably be occasioned at the extent and value of the organized activities at work, for the good of the community, under the control of this Department, as disclosed in the subjoined reports.

Nearly 30 years have elapsed since the creation of a Ministry of Agriculture in this colony, and the sagacity and forethought which dictated this proceeding have been abundantly justified by subsequent events. That office has been filled by a succession of gentlemen who have been actuated by an honorable ambition to advance the most permanent and most valuable of the staple industries of the country; and its exceptional circumstances have led to an immense amount of work being thrown upon the Government which is performed by private enterprise in older communities. The experience gained by farmers in Great Britain and Ireland was found to be of very small utility amidst the novel conditions of soil and climate which prevail in Victoria. Agriculture and horticulture, again, were taken up by numbers of inexperienced persons, and the difficulties with which they found themselves confronted, by reason of their want of previous knowledge, were aggravated by exposure to drought, to bush fires, to occasional floods, to strange vicissitudes of the seasons, and to a host of insect enemies, endowed with an apparently appalling fecundity, to say nothing of those myriads of microscopic organisms which multiply in a literally awful ratio, and prey upon the produce of the soil.

Hence the State had to choose between a *laissez faire* and an almost paternal policy towards an industry which

everywhere underlies the prosperity of civilized communities. For, with these, as with individuals, the acquisition of the means of subsistence is a matter of prime necessity; and when this has been provided for, the profitable disposition of the surplus food supplies in the chief markets of the world, separated from us by nearly half the circumference of the globe, has to engage the attention of producers. But these are so situated and circumstanced by their geographical isolation, and their unacquaintance with the methods and channels of external commerce, as well as by the nature of their daily pursuits, as to disqualify them for the rôle of exporters, so that here, again, the intervention of the Government has been called for, partly in the interests of farmers, graziers, and fruit-growers, and partly to secure uniformity of quality and excellence, in the produce of the soil consigned to British and foreign markets.

How well successive Ministers have discharged these onerous and diversified functions in this colony, and how ably and zealously their efforts have been seconded, and the intentions of the Legislature have been fulfilled by the various officers of this Department, will be best attested by the reports contained in the body of this volume.

In preparing an introductory chapter I have endeavoured to select and to present in a complete form some of the more salient points of the documents sent in; and I desire to record my high appreciation of the zeal and assiduity which have actuated the writers of them in arranging and setting forth the large body of interesting and serviceable information they contain.

D. MARTIN,
Secretary for Agriculture.

Melbourne,
June, 1900.

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INTRODUCTORY CHAPTER.

Theoretical Teaching and Practical Results.

Although the appointment of Dr. F. J. Howell as Scientific Instructor in Agriculture, Agricultural Chemists' branch of this Department, was made less than a twelvemonth ago, the report of the work he has already done in extending and supervising experimental test farms, and in delivering lectures on husbandry, &c., has begun to bear good fruit. His brief experience runs counter to the popular idea that farmers are an apathetic body of men, and goes to show that they are quite alive to the value of sound teaching when conveyed in lucid, intelligent, and attractive language. They are also eager to establish upon their own land test fields for experimentalizing upon with manures ; and as many as 200 applications for these have been sent into the Department.

Dr. Howell's personal observations and inquiries have convinced him "that the most important factor in successful agriculture is, and always will be, the man behind the plough, and that the influence of seasons, good or bad, is really a secondary consideration." As a case in point he cites the instance of a wheat-grower in the Birchip district —Mr. Small, of Narraport—who, by fallowing and proper cultivation of his land, has raised his yield from the local average of 4 bushels per acre to the magnificent return of upwards of 7 bags to the acre ! His system of cultivation will be found described in the Report.

By the liberal use of suitable manures and improved methods of husbandry, Dr. Howell confidently anticipates that, from the area now under cultivation for cereals, we might double and even treble the present "miserable" yield. One means to such an end as this, which would enrich the farmer and immensely increase our exports of breadstuffs, would be by a rotation of crops, which, as he observes, would "not only render the occupation of land generally more profitable, but by its ameliorating and cleansing effects on our soils would cause the production of wheat to become less precarious and costly."

Speaking of agricultural instruction, Dr. Howell insists upon the supreme importance of establishing stations for carrying out independent experiments upon. These, he agrees with Mr. Pearson, should be four in number, each being placed in the centre of a district possessing specific climatic conditions.

On the subject of fruit-growing the same writer gives it as his opinion that "the troubles of our orchards are directly traceable to the reduced vitality of the tree, brought about by soil impoverishment." And, in support of this view, Dr. Howell quotes the experience of Messrs. Godfrey Bros., who from about 4 acres of peach orchard, consisting of poor sandy soil, planted with trees that are twelve years old, gathered 95 cases of fruit after a dressing of 7 cwt. of bonedust to the acre; and when they had followed it up by applying 1 cwt. of concentrated superphosphates, ¾ cwt. of nitrate of soda, and ¾ cwt. of potash chloride per acre, he obtained 614 cases of peaches from the same area.

Plant-food. Counteraction of Drought.

The report of Mr. A. N. Pearson, Chemist for Lands, Agriculture, and Water Supply, corroborates the statements and conclusions of Dr. Howell, for he remarks—"The accumulated evidence of several years of this (experimental field) work has shown that the produce of both cultivated and pasture land may in many cases be doubled and even trebled by the judicious application of the required plant-food, and that this result may in the majority of cases be obtained with considerable profit to the farmer." This is being demonstrated very forcibly by experiments conducted on 49 fields in 28 localities, comprising 939 plots of land, laid out under the direction of Mr. Pearson, who gives in a tabular form the nature and results of the experiments conducted on 24 typical plots, and mentions that he has received upwards of 170 applications for the establishment of what have now become "demonstration fields."

Speaking of the effects of drought upon Australian husbandry, Mr. Pearson makes a remark, the full significance of which will strike most persons who have been accustomed to reflect upon the important subject thus incidentally touched upon. It is this:—"The extent to which the soil moisture may be conserved by sufficient stirring of the

surface soil has not yet been fully recognised in the dry districts. The difference of evaporation from a soil with the surface stirred and from one not stirred may, in the hot summer, be equivalent to 1 inch or more rain a month. By putting the disc harrow over the stubble immediately after harvest, and harrowing the young growing crop once or twice, even an old paddock not fallowed may retain sufficient moisture to insure a substantial crop."

During the year 1899, it deserves to be added, as many as 764 samples were analyzed in the laboratory of Mr. Pearson's branch, besides those undertaken for students' practice, involving a very much greater number of what may be called sub-analyses.

The Dairying Industry.

It is gratifying to observe the increasing interest which is being manifested in this growing industry. Mr. Potts reports that the 51 illustrated lectures which he delivered on the subject last year attracted 11,913 auditors; and that the children attending the State schools in the dairying districts receive with avidity the instruction imparted to them through the same channel; 2,649 children, 183 teachers, and 32 parents availing themselves of it. Apart from the technical knowledge which they acquire in this way, they benefit morally by learning methods of cleanliness and habits of regularity.

In the fulfilment of his duties, Mr. Potts mentions that he visited 127 farms, 57 butter factories, 29 creameries, and 3 cheese factories in the course of the bygone year; and these figures will serve to denote the steady extension of this group of industries.

Continuous investigations as to the relative value of imported and indigenous cultures, have led him to decide upon abandoning the use of the former and distributing only the freshly inoculated indigenous cultures, on account of their obvious superiority.

The Grazing Industry.

The past year, as Mr. Pentland, the Chief Inspector of Stock, reminds us, has been an exceptionally prosperous one, both as regards pasturage, and the prices obtained for stock and wool; while the percentage of cattle attacked by tuberculosis is considerably below that of former years.

During the last two decades, the horses in the colony have nearly doubled in number; milch cows have increased from 329,198 to 431,547; other cattle from 957,069 to 1,368,511; sheep from 10,000,000 to 13,000,000 in round numbers; and pigs from 241,936 to 337,588; and, with respect to future developments, Mr. Pentland remarks that "with good prices for stock and products of all kinds, our resources are practically inexhaustible, other things being equal."

Imports from New South Wales.

Attention is called to an apparent excess of these, which admits, however, of a satisfactory explanation. We annually import 1,000,000 sheep from New South Wales; of which comparatively few enter into local consumption; while the rest do not apparently figure in our exports. But it is only *apparently*, for in reality the overplus finds its way abroad in the shape of frozen and preserved meats. The stores and fat sheep of the neighbouring colony furnish us with the raw material, which we send away as preserved food.

The Yield of Milk.

How much remains to be done, in order to bring up the yield of milk from our milch kine to the high average reached in older countries, is forcibly illustrated by some statistics quoted in Mr. Pentland's report, which show that in certain districts of this colony, the average yield from milkers in first-rate condition reaches as high as from 600 to 700 gallons per annum; while from others, in inferior condition, it falls as low as 300 gallons per annum. But the returns for 1898, showed an average of only 260·2 per annum, which is very little more than half that of the mother country.

Now, the low productiveness of our own dairy stock is chiefly due to two causes—(1) inferiority of breed; and (2) the poor quality of the pastures upon which they are grazed. To remedy the first of these defects, Mr. Pentland suggests a cross between the Ayrshire and the Shorthorn; while for hardihood, he recommends the Kerry as being emphatically "a poor man's cow, which gives more milk in proportion to live weight than any other breed in the world." As to pastures, the kangaroo grass is held to be the most nutritious in the summer months, while the native barley grass is said to be invaluable for winter fodder.

Dairy Stock.

On the whole, Mr. Pentland considers the cattle of this colony compare favorably with that of any country in the world, both as regards health and hardihood. Where our milch kine have deteriorated, it is attributable to inadequate or innutritious feeding, and to drinking impure water. If most dairymen kept smaller herds, and gave them a more liberal diet during the very dry seasons, by supplying them with maize, sugar-beet, Cape barley, and pumpkins, more remunerative returns might be looked for.

Sheep.

The condition of our sheep is declared to be highly satisfactory, as there has been no special mortality. Their quality this year is described as exceptionally fine ; there has been a large exportation of lambs ; and the value of the wool clip of 1899 is estimated at £3,464,500, as against £1,716,000, for the year preceding.

Horses.

Horse stock is represented as continuing to be remarkably free from disease, while, it is observed, "we have everything in our favour as regards the extension of the horse industry, climate and freedom from disease." In fact, the war in South Africa must have had the effect of showing Victorian breeders of this animal not only the magnitude of the demand which a military campaign may suddenly create for suitable remounts for cavalry regiments, and for mounted infantry, but also the specially fine qualities of Australian horses for service in the field. Bred up amidst entirely natural conditions, and exempt from the artificial housing and diet to which those of other countries, with a colder winter climate, are exposed, they resemble in their hardihood, their physical attributes, and in their diminished liability to disease, their kindred in Arabia and other Asiatic countries, which have sent forth, from time to time, some of the most splendid armed horsemen in the world. Even after a sea voyage of some weeks duration, our horses were generally landed in good condition at the ports of South Africa, and proved to be more easily and rapidly acclimatised than those imported from other and colder latitudes.

The campaign in Natal and the Orange Free State, although only of a few months duration, has been extremely calamitous to the animals engaged in cavalry and artillery operations, necessitating the purchase of remounts numbering 42,000 horses and 23,000 mules; and, whenever a great European war occurs, the immense magnitude of the armies which will be brought into action in such an event must of necessity entail a correspondingly large sacrifice of horseflesh, which will have to be made good by drafts upon this kind of stock from South America and Australia; to say nothing of the steady demand which already exists in India, and of the extremely probable call which will be made upon our horse-breeders by the Imperial forces, now that the capabilities of our animals have been tested in scouting operations and on the field of battle. Hence we should be prepared to take advantage of the new demands which are likely to arise for this description of stock, and of the expansion which existing markets promise to undergo. We should, as Mr. Pentland points out, import stud horses and brood mares of the highest character, and pay closer attention to the breeding of new progeny. Our exports of the last, he tells us, show a serious decline, not because there is any contraction of the demand, but because the quality of the supply is not what it should be, owing to our breeders contenting themselves with very inferior stock.

In other countries the breeding of mules appears to be a profitable business, and when we read of large quantities having been purchased at very high prices, on account of their being peculiarly serviceable for draught purposes in connexion with the artillery and the commissariat, in South Africa, we cannot help wishing that we had been in a position to supply our countrymen with this class of animal.

Pigs.

This kind of stock is stated by Mr. Pentland to be remarkably healthy and free from infectious and contagious diseases. An improvment is expected to take place in the breed by the importation of some Tamworth boars, which are believed to be the best to cross with the Berkshire. The raising of these animals constitutes a profitable adjunct to the ordinary business of the dairy farmer, and the export trade is worth while cultivating at present prices.

Dogs.

The Chief Inspector informs us that "High prices have been paid of late years for all kinds of pure-bred dogs, and that it is satisfactory to know that we have in recent times imported some of the best dogs to be found in the old country." These animals continue to enjoy an immunity from the most terrible and dangerous malady (*rabies*) to which their congeners in the other hemisphere are liable.

Our Insect Pests.

The voluminous report of Mr. Charles French, the Government Entomologist, deals with what is unfortunately a very extensive subject, because the climatic conditions of the country are extremely favorable to the development and multiplication of all forms of parasitic life; and these are not held in check, as in northern countries, by the occasional occurrence of winters of exceptional severity. Nor are we, at present, perfectly acquainted with the natural enemies of the many predatory insects whose ravages are so destructive to the products of the soil. And as most of these products are exotics, comparatively few of our indigenous birds possess perhaps those insectivorous instincts which would enable them to become "the winged wardens" of our farms and orchards. Nor, as Mr. French points out, have we, as yet, taken the necessary steps for the protection and conservation of those insects which are the natural allies of the corn and fruit-grower.

The San Jose Scale.

There seems good reason to hope that this obnoxious insect, which was originally introduced from California, will be speedily extirpated, or will "at least be kept in harmless subjection."

Museum and Library.

Mr. French dwells with justifiable satisfaction on the fact that we now possess "the most complete collection of economic entomology in the southern hemisphere," and that it is greatly resorted to by students and by persons seeking practical information. Most of the native birds known to be destroyers of insect life have also been brought together, and the Library, containing upwards of 1,000 volumes, is represented to be "one of the most complete in the colonies."

Fruit Inspection.

Our imports and exports of fruit, which embrace something like 30 varieties, are beginning to assume important dimensions, and necessitate careful inspection. Last year 894,254 packages reached us from external sources, 16,515 of which were condemned; while 8,409 certificates were issued in connexion with 98,417 cases of fruit exported; and 4,000 orchards were visited; and upwards of 1,000 certificates were issued to nurserymen.

Fumigation.

The use of hydrocyanic gas for the destruction of scale insects is now proved to be so efficacious that all other gases have been abandoned; and nine co-operative clubs for its application have already been started. These do so upon naturally beneficial terms, and the experience of American fruit-growers confirms the soundness of the principle and the advantages derivable from its reduction to practice. In the Cape Colony upwards of 24,000 orchard trees are treated in this way, and Mr. French gives some interesting particulars with respect to the morbific effects of the gas upon specific pests at various strengths. His present recommendation being to use not less than 1 oz. to 125 cubic feet of space when treating deciduous trees. Its employment in glass houses appears to be singularly efficacious, without inflicting the slightest injury upon the most delicate plants, except where moisture is present in the air or in the foliage. But as hydrocyanic gas is a deadly poison, it should be used with the utmost caution.

In Mr. French's opinion, every nurseryman who sends out trees for sale should be compelled to erect a fumigator on his premises, and treat his stock in a cyanide chamber before selling it.

It should be observed, however, that fumigation by this process is ineffectual for the destruction of fungous growths.

An American orchardist, it is stated, has treated nearly 4,000 trees (excluding cherries) with crude petroleum, either undiluted or mixed with from 60 to 75 per cent. of water, in the winter, without injury to any one of them; the oil acting in some cases as a stimulus to their growth, vigour, and foliation; the mid-winter appearing to be the most favorable

time for the operation. It proves fatal, by actual contact, to the San Jose Scale, and will soak through masses of it as nothing else will.

An Indigenous Pest.

Allied to the family of the Cicadæ, whose natural home is in the bark of the young gum trees, an insect is reported as having forsaken its primitive habitat and taken to ravaging apple orchards. To counteract its depredations, Mr. French recommends the burning of all prunings; the painting of the stem and larger branches with a mixture of lime, sulphur, and soft soap; and the spraying of the smaller branches with kerosene emulsion or resin compound applied as hot as possible.

The Dark-green Grass Caterpillar.

The larvæ of this moth are such voracious feeders that they devour the natural or artificial herbage of thousands of acres of pasture land, and leave the soil absolutely bare. Nor does there appear to be any mode of arresting its depredations except by keeping the soil continually and thoroughly stirred, so as to destroy the grubs; although a bran and arsenic treatment, it is suggested, would probably prove efficacious.

The Green Hanging Moth.

This is stated to have become terribly destructive to apple trees more especially, and furnishes another instance of an insect having forsaken the diet which had constituted its sustenance for innumerable centuries, in all probability, to prey upon a new substance, as it formely fed upon the Melaleuca, It is described as belonging to a family of moths, of which the largest variety possesses wings measuring 10 inches across, and its voracity appears to be commensurate with its magnitude.

Vegetable Pathology.

A single fact, mentioned by Mr. McAlpine, in his report of the work performed by the pathological branch of this Department, illustrates the economic value of the researches prosecuted by it, and of the prophylactic treatment which those researches enable it to recommend to persons engaged

in the various pursuits of husbandry. He states, upon apparently good authority, that a single visitation of "Stinking Smut," in the year 1898, cost the colony £50,000, and that this disease has been proved to be entirely preventible. In fact, the old medical maxim, *obsta principiis*, appears to possess the same validity and force, as regards the multifarious maladies to which all plant-life is exposed, as it does in relation to the various disorders which afflict the human frame. A diagnosis of the earliest symptoms of vegetable disease by an expert pathologist, and the prompt suppression of the incipient malady, may be the means of saving the community hundreds of thousands of pounds, and of averting ruinous disasters to individual cultivators.

Mr. McAlpine's list of the enemies our farmers and fruit-growers have to cope with is a very formidable one; but in most cases he suggests a specific method of treatment, or indicates where it is to be found, so that if science reveals to us the almost appalling magnitude and the desperate character of the struggle for existence which is continually going on between the vegetable world and the lower forms of animal life which prey upon it, science explains how we may effectually aid the former to resist and vanquish its enemies.

Experiments with Cereals.

In the section of his report which deals with these, the writer tells us, with respect to wheat culture in dry districts, that where there is "thorough cultivation, early sowing, and good varieties suitable to the district, highly profitable yields can be safely reckoned on." The proof of this is furnished by Mr. Cobham, of Waitchie, who reaped as much as 25 bushels 48 lbs. from an acre sown with Port Fairy Ward's Prolific, while Queen's Jubilee, which proved to be a close second, is stated to have achieved a great success in the mallee. Among barleys, Italian Battledore is regarded as one of the best.

The Tobacco Mildew.

It is unpleasant to learn that this malady has become so prevalent in certain parts of the colony as to imperil the industry itself; but Mr. McAlpine is pretty confident that the experiments he is now engaged in will enable him to grapple successfully with the evil.

One apparently anomalous circumstance has found an interesting explanation. The fungus which destroys the tobacco plant in Australia is unknown in the United States. What is the cause of its appearance here? It seems that there has been recently discovered a wild tobacco indigenous to this continent; that it is preyed upon by the fungus already referred to; that this has grown more epicurean in its tastes, and finds a more succulent article of food in the cultivated than in the wild plant.

A Pathological Museum.

Mr. McAlpine advocates the institution of a museum in which specimens and photographs of diseased plants could be exhibited with explanatory cards attached to them, as such a museum, he contends, would be "one of the most effectual means of educating the farmer, the fruit-grower, the vigneron, and the market gardener."

Experimental Orchards.

In order to make fruit-growing a commercial success, the writer of this Report argues that experimental orchards are not less a necessity than experimental farms are to the agriculturist. For, if the average fruit-grower could be shown actual results of a highly profitable character, he would need no more powerful motive than self-interest to impel him to adopt the method by which such favorable results could be shown to have been attained.

Fruit and Special Industries.

The comprehensive report of the expert on fruit and special industries covers a wide area, and embraces many subjects of general as well as particular interest. It is evident that a great impetus has been imparted to orchard and vine culture by the system of giving bonuses; that this industry has made rapid progress during the last few years; and that it has an important future before it. With suitable kinds of fruit, grown according to the most approved methods, Mr. Knight is of opinion that there need be no fear of over-production.

Green Fruit.

For this there is practically an unlimited demand, not only in the United Kingdom, but elsewhere. Unfortunately, however, Victorian growers do not seem to be sufficiently alive to the paramount importance of sending away fruit of the highest quality only, packed with the most scrupulous care, and shipped under such conditions as will insure its being landed in the best possible order. This is all the more imperative, inasmuch as none but high prices in the London market can remunerate the grower, owing to the great outlay for freight and charges. A reduction in these appears to be indispensable to the expansion of the trade.

Inspection.

At present any adequate inspection of fruit intended for exportation is stated to be quite impossible. To remedy this unsatisfactory state of things, Mr. Knight suggests the establishment of a central and several provincial depôts, in which fruit could be repacked and properly graded at such a small charge per case as would make the depôt self-supporting, the work being performed by men specially qualified for it.

Dried Fruits.

The production of these seems to have overtaken the local demand, as regards raisins and apricots; and it is encouraging to learn that considerable quantities are being exported to the other colonies. But the drying of figs and prunes has not yet received the attention it deserves, and the same remark applies with still greater force to apples. Yet the local conditions are so favorable to this industry in all its ramifications that a large and steady increase in it is regarded as inevitable, more particularly as it offers such a favorable opportunity of working off surplus stock in seasons of abundance.

Canned Fruit and Preserves.

To secure a good market for these abroad, it is recommended that glass receptacles should be used instead of tin ones, and that the use of inferior or damaged fruit should be scrupulously avoided.

Fruit Pulp for Export.

There appears to be an almost unlimited demand for pulped fruit in the United Kingdom, and the outlook, with respect to raspberries more particularly, is so cheerful that growers can now reckon upon steadily remunerative prices for their produce, which a few years ago threatened to prove a perfect glut in the local market.

Citrus Fruits.

If planted in good situations, and carefully treated, these "will generally give larger and more reliable returns than most summer fruits;" and there is no reason, the report tells us, why we should depend upon New South Wales, for the bulk of our supply, when we can grow it at our own doors. Seville oranges might likewise be cultivated with great advantage.

Cider.

In a climate like our own, cider, as a summer beverage, has much to recommend it, on account of its refreshing and non-intoxicating qualities, and the sparkling varieties are by no means a bad substitute for champagne. Its production, as Mr. Knight points out, would offer apple-growers a safeguard against over-production and low prices. Pears and peaches may also be advantageously utilized for the manufacture of similar beverages.

Vegetable Fibres.

"There is a large and virtually unlimited demand for these in Europe," writes Mr. Knight. Flax commands a high price in Melbourne, where good samples have commanded as high as £42 per ton, and the yield of the fibre ranges from 6 to 8 cwt. per acre. In fact it is proving to be a steadily profitable crop. The Ramee, or Chinese grass-plant, and Sisal hemp are plants which might be beneficially cultivated in some of the hottest and driest districts of the colony.

Oil Plants.

Some excellent samples of linseed oil have been exhibited in Gippsland, and the author of this Report is of opinion that its production may be regarded as a coming industry. An ordinarily good crop will yield from 15 to 20 bushels of

linseed per acre, and from 28 to 32 per cent. of oil is capable of being expressed from it. The sunflower is likewise indicated as a desirable plant to cultivate for the sake of the oil obtainable from its seeds.

Perfumes and Essential Oils.

The production of these seems to have been pretty well abandoned, owing to the stringency of the Customs regulations with respect to distillation. This is all the more to be regretted because, as Mr. Knight remarks—"Our climate is similar to that of the south of France and Italy, where the business of perfume-making is so extensively practised," while "experience has proved that nearly all the plants commonly used for the production of commercial perfumes and essential oils can be grown to perfection in Victoria."

Insecticide Plants.

The cultivation of these is obviously a matter of the highest importance in a country where insect life is so prolific; but the chief obstacle to the successful production of this industry is stated to be the opposition of wholesale dealers to Australian productions, no matter what may be their quality, on the ground that they are untried novelties. Two varieties of the Chrysanthemum (*Cinerarifolium* and *Roseum*) are easily cultivated, and they yield either a liquid extract or a powder, which is deadly to insects, while the plants themselves are represented as being "of great service in orchards and gardens, by keeping down certain troublesome insect pests."

Tanning Plants.

In addition to the cultivation of the wattle, which is being systematically pursued, it is said, Sumach and the Valonia oak are spoken of as desirable trees to cultivate, for the sake of the tanning material to be derived from them; as was pointed out by the late Baron von Mueller 24 years ago, in his "Select Plants, readily eligible for industrial culture or naturalization in Victoria": a book which deserves to be much more widely known than it appears to be at the present time. Following his judicious lead, Mr. Knight points out the desirability of planting the Osier (*Salix purpurea*) the Broom-corn (*Andropogon Saccheratus*), and the Canary-grass (*Phalaris Canariensis*).

In conclusion, Mr. Knight strongly urges that a systematic inspection should be made of all agricultural products intended for exportation.

Dairy Produce.

The export of agricultural produce, other than cereals and fodder, was greater in 1899 than in any previous year, totalling £1,466,609 in value, of which butter constituted the most important item ; rabbits coming next, and lamb and mutton standing third. In fact, the dairying industry is declared to be in a more flourishing condition than ever before ; while the export trade in milk and cream is steadily growing and promises to assume large dimensions.

Poultry.

Almost unlimited markets for poultry exist abroad ; but, in order to capture them, an improvement in the kinds exported is stated to be urgently required. Our poultry farmers appear to forget, in too many instances, that they have to compete, as poultry raisers, with some of the most shrewd and sagacious breeders and rearers of domestic fowls in the world ; and that consumers everywhere give the preference to those of the best quality.

Fishy Butter.

A great part of Mr. Crowe's report is occupied by a correspondence in reference to complaints made in London of a fishy flavour in some of the butter received from this colony. Samples of the article thus tainted have been submitted to microscopic examination at the Melbourne University, and were found to contain an enormous quantity of yeasts and some bacilli, owing apparently to the use of impure water in washing the butter.

Among the documents appended to this Report is one containing some valuable details of a simple method of preparing a pure starter for cream ripening, furnished by Mr. Pearson, the Chemist for Agriculture.

The Export of Meat.

Thanks to the precautions taken by Victoria flock owners in the selection of sheep and lambs intended for export in the carcass, no complaints were made of their quality in the

markets to which they were consigned, and it is satisfactory to be assured by Dr. Brown that this colony is obtaining a high reputation for its lambs in London; and that unusually heavy as was the export of both sheep and lambs last year, it might have been still heavier if there had been more accommodation at the Government freezing works.

Tinned Meats.

The export of these during the first two months of the present year more than doubled that of the whole of 1899; and there is a reasonable expectation that the War-office will place large orders for tinned meats in the hands of our local exporters for the time to come, which will help to establish the industry on a solid and permanent footing.

Rabbits.

A good many persons will be surprised to learn that during the past year no less than 3,260,000 rabbits and 6,000 hares passed through the freezing chambers of the Government without reckoning those received for similar treatment in private establishments; but Dr. Brown recommends that all canning of these animals for export should be placed under a legal interdict during the months of December, January, and February.

Bone Taint.

This appears to have disappeared in carcasses shipped from Melbourne, and some details given in this Report of experiments made on some sheep slaughtered and frozen on a very hot day, go to show that the taint is not incidental to the freezing process.

Fruit Preservation.

Experiments conducted by Dr. Brown to ascertain the relative perishability of different kinds of fruit, have led him to the conclusion that those varieties which are formed from the ovary and the calyx, such as the apple, pear, and gooseberry, can be kept long enough to meet the requirements of exporters; while, on the other hand, those which are developed from the ovary only as, for example, the grape, the cherry, the plum, peach, and apricot, cannot be prevented from decaying, except under great difficulties. Fruit stored

in a chamber, at a uniform temperature of 40° F. and exposed to a steady current of cold dry air, is placed in a position best adapted to arrest its decomposition.

Fruit Pulp.

Dr. Brown anticipates that the exportation of this article will assume immense proportions, and he states that if the proper system of preserving is to be carried out, it is impossible for pulp to undergo change by any ferment, whether organic or inorganic, so long as the tins are perfect in construction.

Egg Preservation.

As the result of experiments instituted to ascertain how eggs could be best preserved and packed for export, it is believed that when placed in boxes containing sawdust and bran, saturated with formalin (1 in 500) and the sulphide of lime (1 in 100), and kept in a cool chamber at a temperature of 40° F., eggs will retain their freshness for a period of 70 days and upwards.

Diseases of Sheep and Cattle.

Speaking of tuberculosis, Dr. Brown tells us that not more than 7 per cent. of the cattle, nor more than about 5 per cent. of the swine, in this colony are affected with this malady, which is less prevalent here than in any other part of the world. It seems to be largely the result of artificial conditions of life, induced by domestication. Where milch kine are affected, the injection of tuberculin is recommended, and this, it is said, does not impair either the quality or the quantity of the milk they yield.

Pleuro-pneumonia.

Inoculation methods must be here recognised, the report tells us, to guard against an outbreak of this epidemic, and the lymph taken from the chest cavity of a beast which has died of the disease, and free from any other malady, should be employed for the purpose.

Symptomatic Anthrax.

Vaccination is recommended as an efficacious means of fighting this disorder, and the carcasses of all animals which have died of it should be either burned or deeply buried

intact in chloride of lime. The cultivation of infected areas lessens the liability to the disease on the part of animals pasturing there, but their drainage is requisite in order to stamp it out.

Information Wanted.

Mr. Sinclair reports from London a large circulation of, and an increasing demand for, the *Illustrated Handbook of Victoria*, published in 1898, which has been the means of stimulating inquiries for information with respect to the soil, climate, products, and resources of this colony from persons contemplating emigration from the mother country; and, in view of the astonishing ignorance which prevails in Great Britain with respect to this part of the world, he recommends that a collection of exhibits of our agricultural produce should be sent to three or four of the great agricultural shows, held during the summer months in that country, together with a liberal supply of handbooks for distribution.

Burnley School of Horticulture.

Mr. Luffmann's report for the year 1899 denotes the satisfactory results which have attended the opening of the school for female students at the gardens. Seventy-two were enrolled at the outset, of whom 62 presented themselves at the examination, which embraced 32 subjects, and elicited 50 essays, many of which were so good that the director has appended five of them to his report. He mentions that 500 fruit-growers have called upon him for instruction in orchard work, and that several applications have been made to him for male students as managers of fruit-growing estates and directors of private gardens.

Prospects of Commercial Fruit-growing in Victoria.

In the first of three treatises written for the special benefit of orchardists, Mr. Luffmann points out that, in order to become a profitable business, fruit-growing must be entered upon with a proper equipment of practical skill and experience; and that, to make it permanently successful, a thorough knowledge of local conditions of soil and climate is indispensable. Instead of cultivating miscellaneous varieties of orchard trees on one block of land, he recommends a careful ascertainment of the kind of fruit which will flourish best in a given district, and the growth of that exclusively; so that

there would be peach, apple, pear, prune, and citrus regions, the fact being always borne in mind that the fecundity of a tree is rarely maintained for more than five-and-twenty years, so that every generation must plant for itself. Then, again, while the methods of cultivation must be the best attainable, the care bestowed upon the preparation, packing, and marketing must be such as to secure uniformity of quality; and to this end Mr. Luffmann recommends combinations of small growers upon the dairy-factory system. The future of this industry depends almost entirely, he remarks, on the amount of intelligence and organization devoted to it, for we shall secure no good markets, he argues, until larger quantities of higher average quality are produced from compact areas.

Cultivating Orchard Lands.

Mr. Luffmann, after describing the objects of all cultivation of the soil, namely, to liberate, gather, and conserve food for plants, points out that its effect is that of enriching poor soil, and of mitigating or preventing the rank redundancy of richer ones. After giving specific directions for each season of the year he concludes with this concise maxim:—"Learn what plants like, and how to gratify their tastes, and you have mastered the art of cultivating the soil."

The Architecture of Fruit Trees.

Upon the artificial building up of a fruit tree, according to scientific principles, depends its profitable cultivation; and upon the nature of its internal structure hinges its commercial value, writes Mr. Luffmann; and, starting from these premises, he proceeds to give detailed instructions for the preservation and development of those portions of the tree which will not only cause it to be permanently shapely, but will likewise render it highly profitable. Not only so, but its branches will be so vigorous and so firmly posited as that they will not be deflected either by the weight of the fruit they bear or by tempestuous weather.

Students' Essays.

The utility and beneficial results of the lessons imparted by the Director to his students are evidenced by the five essays which are given as appendices to his report. In one of these the writer explains the principles to be observed in

the choice and preparation of orchard and garden soil, as also the measures to be taken for maintaining its fertility. A second deals with the subject of villa gardening, both as regards general design and picturesque effect. A third approaches the question of lemon culture in a practical spirit. A fourth takes the shape of an examination paper, for the purpose of illustrating the very broad scope and general comprehensiveness of the system of instruction pursued at Burnley ; and a fifth contains a select list of twelve good pears, plums, apples, and peaches, and of six prune plums, and good apricots, and gooseberries, and of four almond trees, respectively, which appear to be most eligible for cultivation by persons growing fruit for the local and export markets.

The Phylloxera.

The ravages of this subtle enemy of the vigneron continue to be a source of anxiety to all those who are engaged in an industry from which so much is expected as one of the contributories to our economic wealth and progress. It is just 46 years since it was first noticed as an insect pernicious to agriculture in the United States ; and, since then, it has made the tour of the world. But there seems to be little doubt that it flourished in America far back in pre-historic times ; for the vine itself is indigenous over fully one-half of the northern continent, and Scandinavian voyagers who visited it in the tenth century gave the name of Wineland to a region in which the primitive inhabitants cultivated the grape and converted it into a crude sort of wine. There is every reason to believe, however, that although the phylloxera preyed upon the native varieties, these were so robust in constitution as not to be vitally affected by the parasite. Centuries later, when Europeans began to pour into North America, they found the native grape and its vinous products not at all to their taste, and they introduced cuttings from the vineyards of the old world. But these, although they appeared to thrive for a time, succumbed to some mysterious enemy, which puzzled Von Humboldt to account for. Another scientific observer, after studying the subject *in situ*, read a paper before the Academy of Science in Paris, in 1836, wherein he declared that exotic vines could never be acclimatized and cultivated in the United States of America. Then a certain Mr. Longworth, turning his attention to

the indigenous plant, cultivated it on scientific principles. His example was followed by numerous vignerons, and at the present time the varieties of grapes grown in America are numbered by hundreds.

A French grower named Laliman appears to have been the first to notice that some of the American vines which he had planted, successfully resisted the attacks of the phylloxera, while the European vines growing all around them succumbed to the ravages of the insidious cryptogam ; and profiting by his experience, and at the same time convinced that the remedial measures recommended by the advocates of the application of insecticides, of the submersion of vineyards (where such a proceeding was practicable) and of replanting vineyards in sandy soils were merely palliatives, he and other vignerons rooted up their French stocks and replaced them by cuttings from American vines. And now it is beginning to be universally recognised that there is no other way of effectually combating a scourge which has inflicted such incalculable injury upon European vineyards and has been so destructive in our own. The resistance which certain American vines offer to the phylloxera has become a matter of every day observation, and those who are best qualified to offer an opinion upon so momentous a subject do not hesitate to express their belief that this resistance will be permanent in its endurance, because it is guaranteed, as it were, by the organic structure of these vines. In order to make this clearer to the general reader, it must be pointed out that the cellular tissue of the roots of the American vines is much thicker in substance than that of the roots of most European vines, so that while the puncture of the phylloxera penetrates deeply into the latter, disorganizes them, interrupts the circulation of the sap, and leads to the decomposition and death of the part thus wounded, this is not the case with the American vines. The density of the wood of their roots, and their hardiness, oppose an insuperable obstacle to the perforating apparatus of the insect, which consists of several lancets enclosed in a sucker. Hence the puncture is only superficial, and does not penetrate below the bark ; consequently, there is no disorganization, no interruption of the movement of the sap, and no decomposition, followed by fatal consequences.

There is all the difference between the power of resisting the phylloxera possessed by the European and the American vines respectively, as between a suit of armour made of

pasteboard and one composed of sheets of steel in a combat *à outrance* between two skilful swordsmen. Nature has settled for us the question of how best to wage war upon the worst, because the most deadly, enemy of the vine. She has furnished the American varieties with a coat of mail which she has denied to their more thin-skinned European congeners, and among the kinds which appear to be most eligible for selection that known as *Jacquez* seems to be conspicuous for its vigour, fertility, and the good quality of the wine it produces. The wild *Riparia*, the *Taylor*, the *Solonis*, and the *York Madeira* are also favorably spoken of by French vignerons. The *Jacquez* is said to adapt itself pretty readily to all soils except the very moist; the wild *Riparia* is most at home in those of a dry nature; while the *Taylor*, the *Silonis*, and the *York Madeira* thrive best on virgin soils, having a good depth, and not too arid. How far these American varieties are capable of being modified in their phylloxera-resistant characteristics by the Australian soil and climate, it would be premature to speculate upon.

REPORT BY THE SCIENTIFIC INSTRUCTOR IN AGRICULTURE.

(F. J. Howell, Ph.D.)

My appointment took place in August last, as the result of an advertisement inviting applications for the position of agricultural expert in the Agricultural Chemist's branch of the Department of Agriculture.

The duties were to be the extension and supervision of experimental test fields throughout the colony, the delivery of lectures on the principles and practice of manuring, improved systems of cultivation, and other subjects of agricultural interest. Samples of soils were also to be gathered by the expert throughout Victoria for the purpose of making a soil-survey of the colony, and various vegetable products collected for chemical analysis in the laboratory.

I commenced my lectures a few weeks after receiving the appointment, and have followed up the work almost continuously ever since. The ready response of the various agricultural societies throughout the colony to the intimation of the Department that my services as lecturer were at their disposal is, I think, strong evidence against the farmer being the apathetic individual he is so frequently represented to be. The average farmer is, however, I find, inclined to regard the expert as a man steeped in theory from head to foot, and as one who will probably preach far above his head. I am ignorant of how much of such a belief finds justification in fact, but my five months' experience as lecturer has brought this conviction with it: that if we wish to impress the farmer with the importance of scientific teaching in agriculture the lesson will have to be presented in the simplest of language, and the specialist will require to not only be a thorough master of his particular branch of teaching, but a master also in easy, attractive, and lucid exposition.

The subject of my lecture has the reputation of being a dry, technical, and uninteresting one, but if the opinions of others are to be relied upon, I have succeeded in putting it in a form attractive to the farmer. A second proof that the apathy of the farmer is grossly magnified is found in the ready response to my application for experimental manure test fields in the

various centres at which I have lectured. I have now handed in to the Department applications for over 200 such fields, and it requires little imagination to recognise the splendid basis of fact we shall have to work upon next year, after the results have been obtained from these fields.

The question of the manurial requirements for the greater part of Victoria will have passed from the sphere of guess-work and conjecture into that of absolute certainty. The test fields are so arranged as to give, in the crops harvested, an answer to the requirements of the soil in the essential plant foods, the quantities of manures giving the most profitable returns, and the best applications suited for the climatic conditions of the district.

But important as this question of manuring is, it is not the all-important one, and, in my opinion, is equalled, if not overshadowed, by the great subject of

The Proper Mechanical Cultivation of the Soil.

To call attention to the necessity of this in successful agriculture, I have prepared a special lecture under the name of "Tillage," and hope, after I have dealt with the large number (50) of applications for the lecture on manuring still to to be arranged for, to tour the colony again, directing attention to the equal importance of the study of this side of the new soil science.

While in the country I have made it my business to visit as many of the farms as possible, and come in direct touch with the farmer. This has given me the opportunity of making many inquiries, and of eliciting a number of facts of the very greatest importance. I have recently handed in to the Department a short paper embodying certain of these facts, with a request for it to be published. These facts, important as they are, only confirm an opinion I have long held, viz:—That the most important factor in successful agriculture is, and always will be, the man behind the plough, and that the influence of seasons, good or bad, is really a secondary consideration. As an example of the extent to which the effects of a dry season may be overcome I will give the experience of one man only.

The average of the Mallee, as we know from the returns just published by the Government Statist, is a little over 4 bushels to the acre. The average of the Birchip district

did not, I think, exceed this, and possibly fell below it. Mr. Small, living at Narraport, a few miles away, succeeded, however, by fallowing and proper cultivation, in raising his yield to the magnificent average of over seven bags to the acre. In a communication to me, Mr. Small gave details of his system of working his land, and the crops he obtained, together with the crops obtained on adjoining ground, where other systems of soil preparation had been followed. The facts are of such significance that they are worth posting on every highway throughout the colony. Mr. Small writes—"The land (for fallow) was ploughed in August and September, and harrowed as fast as ploughed. The harrowed ground was brought to a fine tilth later on in the season by a process called logging, which consists of dragging a heavy log (six horses) instead of a roller across the furrows. After the first shower the ground was harrowed again, and just before harvesting the disc was put over the ground, and the logging process repeated. The harrows were used after every shower of rain during the summer, and just prior to sowing about the middle of April, the ground was again harrowed, and the seed drilled in at the rate of one bag to 7 acres, with $\frac{1}{2}$ cwt. of a superphosphate."

There are two kinds of soil on Mr. Small's property, a sandy loam with a retentive clay subsoil, found on the greater portion of the farm, and a black loose soil of great depth. In referring to the returns Mr. Small writes—"The sandy loam sown with red straw wheat went a little over seven bags to the acre. The black loose land sown with Allora spring returned about five bags to the acre. Land adjoining, fallowed, drilled, and manured, but not treated (worked) as mine, returned three bags to the acre, and land fallowed in the ordinary way and sown broadcast without manure ranged from 6 bushels to two bags, according to the class of wheat and land. In one instance, land adjoining fallowed without manure, and sown with a late wheat gave better returns than the last field mentioned, as the late showers benefited this wheat."

These facts are eloquent of the marvellous results that might follow the use of manures and improved systems of cultivation throughout the colony. In place of the miserable average for the colony of 7 bushels to the acre, there is no reason why our returns should not be lifted to twice and perhaps three times that quantity.

But, by the introduction of these improved methods of mechanical cultivation, and the more general use of manures, we have in no way reached anything like the limits of the possible productivity of our wheat lands. There is still another direction in agricultural procedure which, as yet, has received very little attention in Victoria, I refer to the

Rotation of Crops.

In speaking of rotations, I do not wish my idea of the subject to be associated with that of a highly-elaborated system of Flemish garden husbandry. It would be folly to advocate for Victoria the highly-systematized rotation of courses that has been worked out in England and on the Continent. Even if climatic conditions allowed of such a thing, the question of market for many of the products would brand the undertaking as quite impracticable. The contiguity of highly-populous centres will always render possible a market for a variety of products quite impossible under conditions of enormous extent of country and sparse population. Our system of cultivation will of necessity be, for some generations to come, extensive rather than intensive. No doubt, for some very considerable time, the production of wheat will hold, as it now does, by far the most important position in our husbandry; but, even not forgetting the fact, I think it is still possible to introduce certain systems of rotation, which, while allowing wheat the premier position it now holds in our cultivation, will both render the occupation of land generally more profitable, and by its ameliorating and cleansing effects on our soils would cause the production of wheat to become less precarious and costly.

I have partly prepared a lecture on the rotation of crops, treating as yet of the principles of the subject only, but I hope when I have time to back this up with a number of practical illustrations. In visiting some of the farms in our colony, I have learnt that certain crops not generally cultivated, have been profitably grown even in our dry districts, and an interpolation of such crops would, I have little doubt, work out on the side of profit.

But even in the use of manures, improved methods of cultivation and the introduction of certain rotary courses, we are still far away from the ultimate limits of profitable farming. There are, for instance, the varieties of grain best adapted to a particular district to be determined, and that

the determination of such a matter is of very great import, is, I think, clearly brought out in the varying results obtained last year from different varieties by Mr. McAlpine, on the Government experimental plots. The question also of seed selection with a view to increase of prolificness is a matter deserving of every consideration. How much may be done in this way is, I think, apparent in the results obtained by Mr. Pearson. Mr. Pearson, experimenting on wheat for three generations, obtained, he states, "a marked improvement in the prolificness and general quality of the grain."

I have gone a little into detail on these matters, because they are all supposed to be within the scope of my teaching, and they are, in my opinion, most important matters. But when the question is put to me of the educational value of my teaching, then I have no hesitation in saying that the system under which this agricultural instruction is at present pursued, although giving valuable results, might perhaps be very considerably improved upon. For the basis of all agricultural instruction should, in my opinion, be the

Experiment Station.

Certain facts of a very instructive and interesting nature will result from the experimental manure and other test fields established this season on the farms throughout the colony. But in carrying out these experiments we are bound to a great extent by the particular methods pursued by the farmer. We have, for instance, to take the depth of ploughing, period of sowing, and methods of cultivation followed by the farmer, although we are justified in thinking that probably far better results might be obtained by introducing an alteration in all these operations. The permanent experiment station renders possible a greater variety in the tests to be carried out. The effects of subsoiling, deeper ploughing, summer cultivation of the fallows, cultivation of the growing crops, differences in dates of sowing, depth of sowing, and a dozen other questions of importance, can be carefully studied and noted. Various crops can be tried, testing their adaptability for interpolation in courses of rotation, or as fodder plants; grasses considered suitable for the district cultivated, and in fact an endless series of experiments carried out that are quite impossible in the demonstration fields in their present form.

As already suggested by Mr. Pearson, four of these stations at least should be established, each to be regarded as the centre of a surrounding stretch of country of similar climatic conditions.

To meet the slight variations of rainfall, soil, &c., in such a zone, experimental fields as at present could still be put down on a few farms—the fields to be larger than those at present established, and with the secured right from the owner of repeating the experiments over a number of years—and the work to be under the control and supervision of the experiment station for the district.

Lectures could then be given to the farmers on the results of the various experiments carried out on the stations and fields by men with the proper equipment for such a work, and there is no reason to doubt that the same good results would follow here as have undoubtedly followed in other countries.

My remarks, so far, have borne special reference to grain-growing, but I have in no way lost sight of the importance of

The Great Industry of Fruit-growing.

The fact, I find, is gradually being recognised that, to secure profitable returns, manures are just as necessary in the orchard as they have been shown to be on our wheat lands. I am of opinion—an opinion confirmed by a great number of fruit-growers—that very many of the troubles of our orchards are directly traceable to the reduced vitality of the trees, brought about by soil impoverishment, and that a number of these troubles practically cease on the application of manures. A splendid illustration of the benefits following the use of manures is found in the 130-acre orchard of Mr. Grant, of Pakenham. The experience of the Godfrey Bros., a few miles removed, is also of great interest, and well worth giving. Their orchard is a small one, comprising only some 10 acres. The trees are twelve years old, and when the Godfreys first took over the lease, were in a very backward condition. The first year after taking possession, a dressing of 7 cwt. of bonedust to the acre was given; the following year an application of 1 cwt. concentrated superphosphate, ¾ cwt. nitrate of soda, and ¾ cwt. of potash chloride per acre was made. The returns are of great interest. The year following the dressing of bonedust, 95

cases of peaches were picked from a little over 4 acres. The second year the yield went up to 614 cases from the same ground. This return, of course, is not exceptional, but when the poor sandy nature of the country is considered, and the differences in yield before and after manuring compared, the effect of the manures is marvellously striking.

Fruit-growers, perhaps more than farmers, have recognised the value of scientific teaching, and are clamouring for the services of experts in the various branches of their great industry. I have received a very large number of applications from horticultural societies for lectures on manuring and cultivation, and intend devoting my attention to these after the experimental fields have been laid down throughout the colony. The experiment station would render a very valuable service in the question of fruit-manuring. Experiments in fruit-manuring have been carried out by Mr. Pearson, in a few cases with valuable results. But the experiments in this case require to extend over a number of years ; they require constant observation, the determination of the variations in the different trees to permit of proper grouping, a uniform system of pruning, and a great amount of time and trouble in taking the weights of the different pickings. Occasionally one may meet a grower with an enthusiasm and interest in the subject sufficient to guarantee all these operations being carried out accurately, but the experiment station alone, I think, offers facilities for the work being performed as it should be.

REPORT OF THE CHEMIST FOR LANDS, AGRICULTURE, AND VICTORIAN WATER SUPPLY.

(A. N. Pearson.)

During the year 1899, this office has undergone material development, and although it is still small as compared with what is needed, to do thoroughly the agricultural work of this country, it is now in a position to do it much more effectively than when the staff provided by the Agricultural Department was limited to one assistant analyst and one junior assistant.

In July, acting under instructions from the Hon. J. W. Taverner, then Minister of Agriculture, I submitted a memorandum in which I stated that, as a beginning, this office needed the appointment of—1st, a travelling assistant to deliver lectures to the farmers on tillage, manuring, rotations, feeding, &c., to superintend experimental and demonstration fields, to gather samples of manures in connexion with the Artificial Fertilizers Act, to collect samples of soil for a soil survey of the colony, and also samples of agricultural produce of all kinds for the systematic examination of the produce of the country. 2nd, a shorthand and type-writing clerk to relieve me of the increasing clerical work which occupied nearly all my time. 3rd, another qualified analyst ; and 4th, of a paid pupil, as was provided before the period of retrenchment, but since discontinued. In March I suggested, as an alternative to the appointment of a qualified analyst, that positions as pupil analysts for twelve months at a small salary might be offered to those students of the Schools of Mines, and other technical schools of the colony, who did well at the annual chemical examinations held by the Education Department. As the chemical examiner of these schools, I was in a position to judge of the qualifications of the students. This suggestion was agreed to by the Cabinet, and three pupil analysts were accordingly appointed in June and July at a salary of £50 each for twelve months. In August the Cabinet sanctioned the appointment of a travelling assistant at a salary of £350 per annum, inclusive of travelling expenses. Applications were

invited by advertisement, and the selected candidate was Dr. F. J. Howell, Ph.D., whose qualifications included seven years' study in European universities, with a degree taken *cum laude*, and six years' experience of successful colonial farming, both on his own farm and elsewhere. The request for a clerk was referred to the Public Service Board, who called for a report of the work done by this office during the three years 1896–7 to 1898–9. This report was furnished, and immediately the necessary steps were taken for making the appointment. Mr. J. C. Hatton, formerly a telegraph operator, and some time temporarily in the Lands Department, was permanently transferred to this office; he joined in October, and has since shown himself to be a careful and earnest officer, who takes an intelligent interest in his work. Besides these additions, the services of Mr. A. C. Drevermann, who had previously been studying the chemistry of essential oils in this laboratory, were placed at my disposal for general work.

As a result of these changes, I have had at my command a staff capable of efficiently dealing with a much larger amount of work than heretofore; in fact it is the first time in my official existence that I have been able to execute the work of the office with any real pleasure or satisfaction. It is only right that I should express my gratitude to all who have assisted in bringing about this result, including the Hon. Wm. McCulloch, who, as acting Minister of Agriculture, readily approved of the proposed increases; Sir George Turner, and the members of his Cabinet; Mr. D. Martin, the Secretary for Agriculture; and various members of Parliament, including the Hon. Geo. Graham (now Minister of Agriculture), and leading public men. I am also much indebted to the daily and weekly press of all sections which, in leading articles and otherwise, have advocated a more generous development of this office, on the grounds of its great potential usefulness to the country.

The work of this office may be considered under the headings of Field Work, Laboratory Work, and Lecture and Publication Work.

Field Work.

The most important work at present is the experimental field work. This was commenced in 1887, during the Ministry of the Hon. J. L. Dow, who approved of £300 annually

being set apart for the purpose. The object at first was to obtain some definite information as to the action of manures in the various districts of Victoria. Previous to the commencement of this work, no definite facts bearing upon the matter were at hand. The accumulated evidence of several years of this work has shown that the produce of both cultivated and pasture land may in many cases be doubled, and even trebled, by the judicious application of the required plant food, and that this result may in the majority of cases be obtained with considerable profit to the farmer. At first these fields were of a purely experimental character for the purpose of gaining information required to guide this office in giving advice to the farmers, and they still have this experimental purpose. But as years have progressed they have assumed more and more the character of demonstration fields, having the additional object of demonstrating and proving to the farmers that the advice given by this office is sound and practical, and may be adopted with confidence. During the years of retrenchment this field work was considerably curtailed. In 1896 there were only eight of these fields ; in 1897 there were twelve ; in 1898 there were 24 ; and in 1899 there were 49, as shown by the following list :—

(2)	Ardmona ...	Grapes and apricots ...	40 plots.
(6)	Bayswater ...	Potatoes and beans ...	72 „
	Berrimal ...	Wheat	15 „
(3)	Bunyip South	Oats, potatoes, and lupines	63 „
	Corack East ...	Wheat	15 „
	Croydon ...	Potatoes and beans ...	30 „
(2)	Doncaster ...	Cherries and vines ...	47 „
	Drysdale ...	Onions	15 „
	Garvoc ...	Wheat	15 „
	Geelong ...	Onion disease ...	18 „
	Gembrook North	Oats and barley ...	12 „
	Gooroc ...	Wheat	15 „
	Healesville ...	Raspberries	18 „
(2)	Ingliston ...	Oats and peas ...	30 „
	Jeparit ...	Wheat	15 „
(2)	Kinglake ...	Fruit-trees	40 „
	Koroit ...	Potatoes	18 „
	Lancefield ...	Potatoes	12 „
(6)	Leongatha ...	Oats, potatoes, and lupines	114 „
(3)	Pakenham ...	Apples	96 „

	Panton Hill ...	Apples ...	...	20 plots.
	Royal Horticultural Gardens (Burnley)	Apples ...	...	24 „
	Ruffy ...	Wheat	...	15 „
	Rutherglen ...	Vines ...	...	18 „
	St. Arnaud ...	Wheat ...	...	15 „
	Wallington ...	Oats ...	...	10 „
	Wandin Yallock	Raspberries ...	...	28 „
(3)	Werribee ...	Oats ...	...	99 „
	Yanac ...	Wheat ...	...	19 „
	Total 49 fields in 28 localities containing ...			939 plots.

The work in connexion with these fields is very heavy. Hitherto they have been laid out by the farmers themselves; and the work of this office has consisted in the preliminary correspondence, the final preparation of plans and of detailed instructions for laying out the plots, the preparation of lists of manures, and the issuing of instructions for despatching the same. The nature of the instructions may be gathered from the following copy of those issued to Mr. Peter McVicars, of Koroit, who has undertaken experiments in regard to manuring potatoes in the volcanic soils of that district:—

Agricultural Laboratory,
25th July, 1899.

Peter McVicars, Esq., Koroit.

Dear Sir,—

I have received your note of the 20th, and now send plan of experimental plots.

There are 24 plots in all. Eight of these are unmanured, there being one unmanured plot against every manured. This experience has shown me to be a desirable provision in all field manure experiments.

The plots are 145 feet long and 12½ feet wide, and are therefore 1/24th acre in area. The whole field will therefore occupy 1 acre. There will be five rows of potatoes in each plot, but only the three inner rows will be weighed at harvest-time as the two outer rows are influenced to some extent by the treatment of the adjacent plot.

At the two sides of the field are 6-ft. pathways; and at the two ends are border plots in which potatoes are planted at the same time as in the other plots, but which are not counted in as part of the experiment.

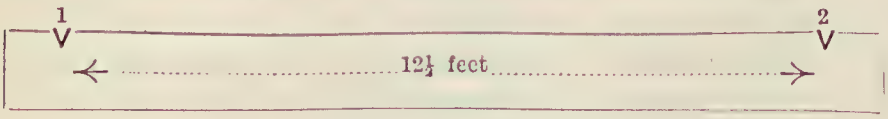
The treatment of the different plots is shown on the accompanying sheet.

For laying out the plots the following has, by experience, been found the simplest and most expeditious way:—

From a point marked *A* on the accompanying plan, plough a straight line *AB*, about 5 chains long. Put a stout peg in the middle of the furrow

at *B*. From this peg plough another straight line *BC* at right angles to *AB*. Measure off the point *C*, 145 feet (2 chains 20 links) from *B*, and put in another stout peg at *C*.

Then take a 14 or 15 feet batten, having two V-shaped notches cut in it, the notches being exactly 12½ feet from the bottom of the one to the bottom of the other, as shown in the following sketch :—



Place the batten along the furrow *AB* so that the notch 1 fits on to the peg *B*, and put in another peg in the middle of the furrow at notch 2, and call this peg 1 (it will mark the first corner of plot 1). Then move the batten down the furrow *AB* so that notch 1 fits on to peg 1, and put in another peg at notch 2 and call this peg 2 (it will mark the corner of plot 2). Go on in this way to peg 3, then to peg 4, and so on to peg 24, and finish up with peg *A*.

Then from peg *A* mark out with the plough another furrow *AD*, at right angles to *AB*. Measure off the point *D* 145 feet (2 chains 20 links) from *A* and put in peg *D*.

Then from peg D plough a straight furrow to peg *C*. Now take the batten and, starting from peg *C*, put in all the pegs along the line *CD*. It may be that owing to the lines *AD* or *BC* not being ploughed exactly at right angles to *AB*, that the peg *D* will be found to be not exactly in its proper place ; but this will not matter, because the point is the outer corner of the border plot, the correct size of which is of no importance.

Next, starting from peg 1 in *CD*, plough a straight furrow to peg 1 in *AB*. Then from peg 2 in *AB* plough a straight furrow to peg 2 in *CD*, and so on until all the plots are marked out.

The lime should then be sown broadcast on plots 18 and 19, and should be harrowed or ploughed in.

It will be better not to apply the other manures until a week or ten days after applying the lime.

Great care is needed to avoid the manure being blown from one plot to another when applying ; a calm day is necessary.

The manures are all in bags numbered for each plot, so that there can be no possibility of mistake. It is better to still further avoid mistakes by carrying each bag on to its proper plot before opening any of them.

The manures should be spread broadcast, and then preferably ploughed in. If, however, there be any special objection to ploughing them in, they may be harrowed in.

The potatoes may be planted immediately after applying the manures. There should be the same weight of potato sets to each plot ; and it is desirable that the sets should be of as uniform size as possible.

Plots 22 and 24 receive exceptional treatment ; no potatoes are to be planted in them this year, but only lupines, which will be allowed to go to seed. Potatoes will be planted in these plots next year.

If you think you will have any difficulty about laying out the plots I will try and spare a day to come down and help in the matter.

The manures have been ordered, and will be ready in a few days. The lime will be sent at once, without waiting for the other manures, so that you need not be delayed.

Yours faithfully,

A. N. PEARSON,
Chemist for Agriculture, &c.

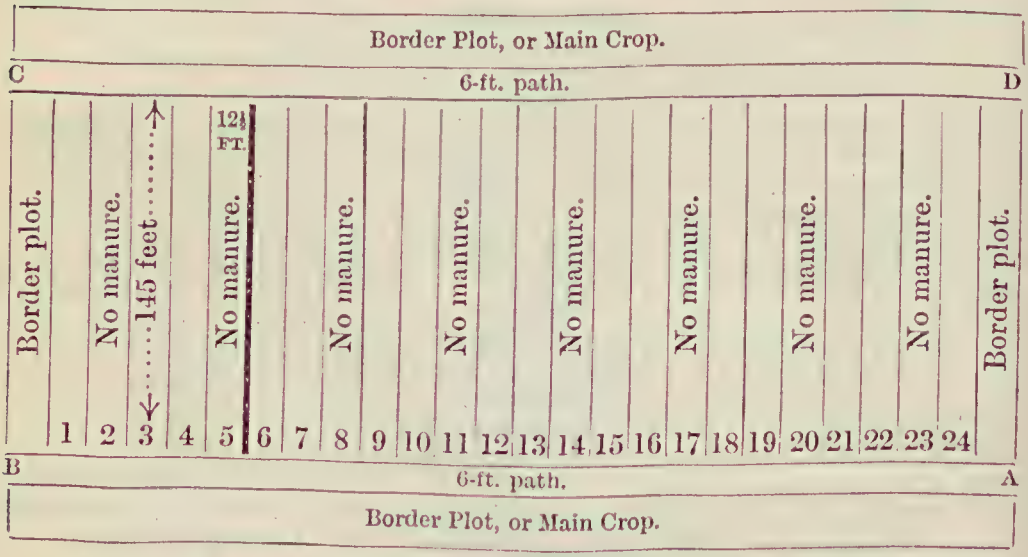
MANURING OF POTATO PLOTS (MR. McVICAR'S FARM), KOROIT, 1899-1900.

Plot.	Plant Food.	Per acre.	Given as—	Per acre.	Per plot.	
		lbs.		cwt.	lbs. oz.	
1.	Nitrogen ...	27	Nitrate of soda	1½	7 0	Quantity plots.
	Phosphoric acid	26	Concentrated Superphosphate	½	2 5⅓	
	Potash ...	38	Potash Chloride	½	2 5⅓	
2.	No manure.					
3.	Nitrogen ...	54	Nitrate of soda	3	14 0	
	Phosphoric acid	52	Concentrated Superphosphate	1	4 10⅔	
	Potash ...	76	Potash Chloride	1	4 10⅔	
4.	Nitrogen ...	81	Nitrate of soda	4½	21 0	
	Phosphoric acid	78	Concentrated Superphosphate	1½	7 0	
	Potash ...	104	Potash Chloride	1½	7 0	
5.	No manure.					
6.	Phosphoric acid	78	Concentrated Superphosphate	1½	7 0	Nitrogen plot.
	Potash ...	104	Potash Chloride	1½	7 0	
7.	Nitrogen ...	81	Nitrate of soda	4½	21 0	Phosphoric acid plot.
	Potash ...	104	Potash Chloride	1½	7 0	
8.	No manure.					
9.	Nitrogen ...	81	Nitrate of soda	4½	21 0	Potash plot.
	Phosphoric acid	78	Concentrated Superphosphate	1½	7 0	
10.	Nitrogen ...	81	Sulphate of ammonia	3⅜	16 0	Sulphate of ammonia plot.
	Phosphoric acid	78	Concentrated Superphosphate	1½	7 0	
	Potash ...	104	Potash Chloride	1½	7 0	
11.	No manure.					
12.	Nitrogen ...	81	Nitrate of soda	4½	21 0	Thomas Phosphate plot.
	Phosphoric acid	105	Thomas Phosphate	5⅔	25 0	
	Potash ...	104	Potash Chloride	1½	7 0	
13.	Nitrogen ...	81	Nitrate of soda	4½	21 0	Precipitated Phosphate plots.
	Phosphoric acid	104	Precipitated Phosphate	1⅘	8 6	
	Potash ...	104	Potash Chloride	1½	7 0	
14.	No manure.					
15.	Nitrogen ...	81	Nitrate of soda	4½	21 0	
	Phosphoric acid	104	Precipitate Phosphate	1⅘	8 6	
	Potash ...	104	Potash Chloride	1½	7 0	Gypsum plots.
	Gypsum ...	448	Gypsum ...	4	18 10	
16.	Gypsum ...	448	Gypsum ...	4	18 10	
17.	No manure.					

MANURING OF POTATO PLOTS—*continued.*

Plot.	Plant food.	Per acre.	Given as—	Per acre.	Per plot.	
		lbs.		cwt.	lbs. oz.	
18.	Lime ...	1 ton	Lime (slaked) ...	1 ton	93 0	Limed plots.
19.	Limed and same as plot 10	...	Lime (slaked)...	1 ton	93 0	
			Sulphate of ammonia	3⅜	16 0	
			Concentrated Superphosphate	1½	7 0	
			Potash Chloride	1½	7 0	
20.	No manure.					
21.	Farmyard manure	...	Farmyard manure	20 tons	16½ cwt.	Farmyard manure plot
22.	Nitrogen ...	...	Lupines ...	...	...	Lupine plots.
	Phosphoric acid	78	Concentrated Superphosphate	1½	7 0	
	Potash	104	Potash Sulphate	1⅔	7 12	
23.	No manure.					
24.	Nitrogen ...	...	Lupiness ...	...	...	
	Phosphoric acid	78	Concentrated Superphosphate	1½	7 0	
	Potash ...	104	Potash Sulphate	1⅔	7 12	
	Gypsum ...	448	Gypsum ...	4	18 10	

PLAN OF POTATO PLOTS ON MR. MCVICAR'S FARM, KOROIT, 1899–1900.



Plots 12½ feet by 145 feet. Five rows of potatoes, 2½ feet apart, in each, but only the three inner rows to be weighed at harvest time. The weight of the three rows multiplied by 40 will give the yield per acre.

A. N. PEARSON.
25.7.99.

Only a few of the results of last year's fields have yet been received. Amongst the most interesting of these are the returns from the wheat-growing districts of the north-west. The following is a tabulated statement of these returns :—

WHEAT EXPERIMENTS IN THE NORTH-WEST.

Table of Results.

	Early Sown.		Late Sown.			Average of Five Stations.	Natural Yield without Manure.	Gain due to Manure.
	Mt. Pleasant. Mr. Telford. Sown 21.4.99. Fallow.	Gooroc. Mr Scott. Sown 28.4.99. Fallow.	Berrimal. Mr. Mackay. Sown 19.6.99.† Very patchy.	Corack East. Mr. LeLievre. Sown end of June.‡ Old paddock.	Jeparit. Mr. Witney. Sown end of June.§ Fallow.			
	bushels.	bushels.	bushels.	bushels.	bushels.	bushels.	bushels.	bushels.
1.	16·46	14·97	7·42	4·07	7·90	10·16	7·92	2·24
*2.	12·51	13·38	6·08	3·79	3·84	7·92		
3.	18·22	16·56	9·43	5·17	13·60	12·60	7·90	4·70
4.	18·22	16·42	11·35	5·17	14·93	13·22	7·89	5·33
*5.	11·63	13·24	6·95	3·86	3·84	7·88		
6.	15·58	15·43	8·34	4·55	7·03	10·19	7·92	2·27
7.	13·84	15·23	6·18	3·66	6·59	9·10	7·97	1·13
*8.	12·73	16·56	3·36	3·38	4·06	8·02		
9.	13·84	18·80	3·48	4·55	7·90	9·71	8·02	1·69
10.	13·39	16·56	4·64	5·28	7·68	9·51	8·01	1·50
*11.	12·08	15·09	4·75	4·38	3·73	8·01		
12.	14·27	16·56	7·65	5·51	9·00	10·60	8·12	2·48
13.	13·84	16·29	8·23	5·34	9·66	10·67	8·24	2·43
*14.	11·19	16·03	7·07	3·58	3·95	8·36		
15.	14·27	17·88	6·95	2·89	4·83	9·36	8·36	1·00

In only one of these cases, namely, Corack East, were the returns from the manuring too small to repay the cost of the manure. This exception was due to a drought of unprecedented severity in that locality. But there was almost as severe a drought at Jeparit, and yet the increased yields there were highly profitable, and it is probable that, with a different system of cultivation, the results at Corack East, notwithstanding the drought, would have been profitable. The effects of drought must of course always be felt to

* Unmanured.

† Heavy rain day after sowing; land flooded; under water for days. Most of the seed killed.

‡ During four months after sowing only ·77 inches rain. Wheat only 3 inches high four months after sowing.

§ Drought.

a considerable degree, but the extent to which the soil moisture may be conserved by sufficient stirring of the soil surface has not yet been fully recognised in the dry districts. The difference of evaporation from a soil with the surface stirred and from one not stirred may in the hot summer be equivalent to 1 inch or more of rain a month. By putting the disc harrows over the stubble immediately after harvest, and by harrowing the young growing crop once or twice, even an old paddock, not fallowed, may retain sufficient moisture to insure a substantial crop.

The most successful of the five fields were those of Mr. Telford, at St. Arnaud, and Mr. Witney, of Jeparit. The profitableness of the manuring in these two cases is briefly shown in the following table:—

Plot.	Amount of Fertilizer used per acre.	Cost of Fertilizer per acre.	Gain due to Fertilizer per acre.		
			—	Bushels of wheat.	Net gain, reckoning wheat at 2s.
1	10 lbs.	1s. 1½d.	St. Arnaud ...	3·95	6s. 9½d.
			Jeparit ...	4·06	7s.
3	20 lbs.	2s. 3d.	St. Arnaud ...	6·00	9s. 9d.
			Jeparit ...	9·76	17s. 3d.
4	30 lbs.	3s. 4½d.	St. Arnaud ...	6·29	9s. 2½d.
			Jeparit ...	11·09	18s. 9½d.

Notwithstanding the care taken in issuing instructions, it has been found that only a percentage of the fields are laid out by the farmers themselves with the necessary attention to details. Experimenting, like all other kind of work, requires experience and training for its satisfactory execution. As these demonstration fields are now attracting a very considerable amount of attention, over 170 applications for their establishment during the coming season having been already received, I have proposed, and the Hon. Geo. Graham, Minister of Agriculture, has approved, that they shall be laid out in future under the direct supervision of this office. For this purpose, four drills, specially altered for laying out experimental plots, have been ordered, and Dr. Howell and three others, temporarily employed during the sowing season, will each take charge of one of these drills, and travel through the wheat districts laying out the fields.

Laboratory Work.

The following is a classified list of the samples received during the year for analysis or report :—

Soils and subsoils	270
Manures	213
Minerals, limestones, &c.	12
Waters	36
Fodders and vegetable products ...	6
Plant ashes	2
Oils, essential oils, and fats	8
Milks	4
Butters	28
Salts and preservatives	6
Bluestone	10
Cow's stomach	1
Waterproof cloth for police	1
Products of experimental fields ...	106
Other substances	5
Total	708

The more important of the water samples, and several of the soil samples, the butters, and some manures were gathered by myself or some member of the staff.

The number of analyses made, and of samples analyzed, during the year was as follows :—

	Number of Analyses.	Number of Samples analyzed.
Soils—General analysis for the public	386 ...	193
„ „ „ „ students' practice	14 ...	—
Soils—Chlorine and Total Salts, only for the public	333 ...	333
Soils—Chlorine and Total Salts, for students' practice	16 ...	—
Manures, for the public	268 ...	140
„ „ students' practice ...	41 ...	—
Waters	48 ...	36
Miscellaneous, for the general public	108 ...	61
„ for students' practice	21 ...	—
Totals :—Analyses ...	1,235 Samples analyzed.	764

A mere statement of the number of samples analyzed does not show the actual amount of work done, as the amount of work in different kinds of analysis varies considerably, there being 20 or 25 times as much in some kinds as in others. In a former report, I assigned certain marks of value to each kind, so as to make a comparison possible. Assigning the same marks to the above returns, and comparing them with years in which they were formerly valued in the same way, the following comparative figures are obtained :—

COMPARATIVE VALUE OF ANALYSES DONE.

1888–9			3,742
1889–90			8,301
1899	1st half-year	4,284	13,145
	2nd half-year	8,301	

Nearly all the samples, excepting the soils for chlorine and total salts only, were analyzed in duplicate by different analysts, acting wholly apart, and where the results did not agree within close enough limits the analyses were repeated. After a lengthened experience I am convinced that such a system insures a reliability of work which cannot be obtained in any other way.

The cost to the Government of the analysis of the above 764 samples has, I estimate, been £948, or an average of £1 4s. 10d. per sample. That this is not an excessive charge is shown by the fact that the average fee readily paid by the public for manure analysis has been £1 6s. 6d. per sample, and those who have paid these fees have acknowledged that they could not get such analyses done elsewhere for so low a fee. I estimate that this work could not have been done by a private analyst for less than the following :—

	£	*s.*	*d.*
193 soils at £3 3s.	605	17	0
333 soils for chlorine and total salts at 7s. 9d.	129	0	9
140 manures at £2 2s.	294	0	0
31 waters at £2 2s.	65	2	0
67 miscellaneous at £1 1s. ...	68	7	0
764 samples	£1,162	6	9

or an average of £1 10s. 6d. per sample.

A cheaper and more expeditious method of estimating phosphoric acids in manures has long been a desideratum.

There are cheaper methods, but unfortunately they are unreliable. The invention of a rapid volumetric method has recently been announced by Dr. Sigismund Littmann. I have tried it, and found that when used with certain precautions it will probably be sufficiently reliable for most ordinary cases. Perhaps we may be able to adopt it, reserving the more perfect methods for cases in dispute and other cases where absolute accuracy is demanded.

The most absorbing of the laboratory work is the soil analysis. It is very costly, and for some years past I have done all I could to discourage it. It absorbs time which could be more profitably applied to other pressing work. Not that soil analysis has not important uses, but the issue of soil reports to farmers under present conditions is not nearly so useful as the establishment of demonstration fields, for in the latter case the farmer can see with his own eyes the value of the information given, whereas with a written soil report, he may doubt it.

Every effort has been made to issue soil reports of a useful kind. The following sample indicates this :—

DEPARTMENT OF AGRICULTURE.

Agricultural Laboratory,
440 Lonsdale-street,
Melbourne, 8th July, 1899.

Sample No. 6907–8.

REPORT ON ANALYSIS OF SOIL AND SUBSOIL FROM PHILLIP ISLAND.
(Forwarded by Mr. J. Lawson, 16 and 16A Viaduct Buildings, Flinders-street.)

The samples on analysis were found to contain :—

Parts in 100,000.	Nitrogen.	Phosphoric Acid.	Potash.	Lime.	Chlorine.
SOIL : 0–1 foot— Light-brown fine sandy clay, permeable and friable ...	148	40	36	151	12
SUBSOIL : 1–2 feet— Yellowish-brown plastic clay, permeable ...	68	52	65	130	38
It may be considered that a first-class soil should contain	Not less than 250	150	200	400	Not more than 35

From the above figures it will be seen that the soil is poor in every respect. It is particularly poor in phosphoric acid and potash.

It would be well to lime the soil occasionally, by applying 15 cwt. per acre of freshly slaked lime, broadcast, early in the rainy season, and immediately harrowing in.

Such a soil as this could be made to grow any crops, if it be suitably treated. Everything depends on the cost of the treatment, and on the market for the produce.

Hay-growing, oats for grain, barley, and rye, are the easiest to grow, but they need plentiful supplies of nitrogen, which must be given either as nitrate of soda, sulphate of ammonia, dried blood, farmyard manure, seaweed, or by means of green manuring with leguminous crops such as lupines, crimson clover, peas, or beans, or rotation with such leguminous crops. Leguminous crops when grown in rotation, or as green manure, enrich the soil in nitrogen. Rye and tares is a good hay crop to grow, as the tares being leguminous draw nitrogen from the air, and the rye makes use of the nitrogen.

Such land would be suitable for grazing if sown with good grasses. Before sowing the grasses, it would be well to lime the soil, and six or eight weeks afterwards to manure it with the following mixture :—

per acre.
1½ cwt. sulphate of ammonia.
1 cwt. concentrated superphosphate.
¾ cwt. potash chloride.

The following mixture of grass seeds may then be sown :—

Poa pratensis (Kentucky blue grass)	4 lbs.
Festuca ovina (sheep fescue)	2 ,,
Festuca pratensis (meadow fescue)	2 ,,
Festuca rubra (red fescue)	2 ,,
Lolium perenne (perennial rye grass)	20 ,,
Dactylus glomerata (cocksfoot)	10 ,,
Phleum pratense (Timothy)	4 ,,
Alopecurus pratensis (meadow foxtail)	4 ,,
Anthoxanthum odoratum (sweet vernal)	2 ,,
Cynosurus cristatus (crested dog's tail)	3 ,,
Trifolium hybridum (alsike clover)	4 ,,
Trifolium repens (white clover)	4 ,,
Medicago lupulina (trefoil)	3 ,,

For ordinary hay and cereal crops the manuring should be—

1½ cwt. sulphate of ammonia.
½ cwt concentrated superphosphate.
½ cwt. potash chloride.

If leguminous crops are grown they need no sulphate of ammonia, and the subsequent cereal crop will need none.

For root crops the following will probably be needed :—

per acre.
3 cwt. sulphate of ammonia.
1 cwt. concentrated superphosphate.
1 cwt. potash chloride.

If seaweed is obtainable it may be used as manure at the rate of 20 loads per acre, ⅓ cwt. of concentrated superphosphate being used in addition to it. No other manure will then be needed.

A soil such as this may advantageously be used for the growth of hardy fruits, such as apples, pears, plums, and cherries, also vines ; but the yield without manure will be only moderate.

A. N. PEARSON,
Chemist for Lands, Agriculture, &c.

In the majority of cases these reports are received even without acknowledgment; and it is doubtful if many who receive them put the information given to practical use. In some cases, however, they are received with warm thanks, and the recipients communicate afterwards a statement of the good results they have obtained by applying the information given. Copies of pamphlets on manuring and soil cultivation are generally sent with the reports.

It is intended in future to gather samples from the unmanured plots of the experimental fields, and to analyze these samples in connexion with a systematic soil survey of the colony. In this way the farmers will get much more valuable soil analysis than they can by sending in samples promiscuously, as hitherto.

Lectures, Pamphlets, Reports, Etc.

During the year 1899 I delivered lectures at Port Fairy and Geelong on manures and manuring, the lectures being in the main a condensation of my pamphlet on the subject.

Nearly 200 applications for lectures have been received by Dr. Howell, and it will take him several months to meet them. In 1899 he delivered fifteen of these. At present he lectures on the principles and methods of soil cultivation, manuring, feeding, and so forth. Wherever he has gone he has been well received, in some cases enthusiastically so, both by the farmers and by the country press. Besides lecturing, he visits as many farmers as he can on their farms, and at his lectures he distributes useful pamphlets and takes the names of those who desire to have demonstration fields established on their farms. The great interest now taken in these fields is largely the result of his work.

The following special reports have been prepared during the year :—

Report on Proposed Scheme for Utilization of Lake Tyrell as a Fresh Water Storage Basin (for Department of Victorian Water Supply)	2.3.99
Report on Proposal to Pump Barwon River Water into Geelong Mains (for Department of Victorian Water Supply)	6.3.99
Brief History of Pioneering Work in Introducing the System of Pasteurization into Victorian Butter-making	18.5.99
A Simple Method of Preparing a Pure Starter for Butter-making in Dairy Factories ...	17.5.99

The Detection of Beestings in Mixed Milks ...	15.5.99
Manures and Manuring. Second enlarged edition, with Rules for Valuation and List of Melbourne Prices	30.5.99
Report on Salt in Mildura Soils, with Proposal for Soil Survey of Mildura	22.6.99
Report on the Operations of the Chemist for Lands, Agriculture, and Water Supply for years 1896–7 to 1898–9	3.7.99
Results of 1898–9, Onion Disease Experiments, Geelong	22.7.99
Report on Proposed Soil Survey of the Colony of Victoria	6.10.99
Report on Proposed Establishment of Four Experiment Stations in Victoria	6.10.99
Report on Soils at Pomona in connexion with so-called "Die-back" affecting the Apple Orchards	15.12.99

Several of these reports involved much more work in the preparation than appears on the surface. For instance, the last report involved an inspection of the orchard by Dr. Howell, the gathering and analysis of 30 soil samples, taken down to a depth of 5 feet, from affected and unaffected areas, a careful comparison of results, and examination of the whole subject.

The clerical work during the year was as follows :—

Samples received, numbered, and entered in the Sample Book, with a *précis* of information concerning them	609
Outward letters and reports, copied into Letter Book	1,110
Pages of foolscap Letter Book, mostly closely written, or type-written, occupied by above outward letters and reports	998
Orders for goods, entered in Order Book ...	102
Receipts for urgency fees, &c., entered in Account Book	104
Accounts checked, entered in Account Book ...	210
Total outward papers	1,526
Analysis returns checked	4,600

The fees received for urgency analyses, and for tuition, amounted to £165 19s.

Tuition in analysis, &c., was given to nine students.

Wheat-manuring Experiments in the North-west in 1899–1900.

TABLE OF RESULTS.

	Early Sown.		Late Sown.					
	Mount Pleasant. Mr. Telford. Sown 21.4.99. Fallow.	Gooroc. Mr. Scott. Sown 19.5.99. Fallow.	Berrimal. Mr. Mackay. Sown 19.6.99.† Very patchy.	Corack East. Mr. Le Lievre. Sown end of June.‡ Old paddock.	Jeparit. Mr. Witney. Sown end of June § Fallow.	Average of Five Stations.	Natural Yield without Manure.	Gain due to Manure.
								bushels.
1.	16·46	14·97	7·42	4·07	7·90	10·16	7·92	2·24
*2.	12·51	13·38	6·08	3·79	3·84	7·92	...	...
3.	18·22	16·56	9·43	5·17	13·60	12·60	7·90	4·70
4.	18·22	16·42	11·35	5·17	14·93	13·22	7·89	5·33
*5.	11·63	13·24	6·95	3·86	3·84	7·88	...	...
6.	15·58	15·43	8·34	4·55	7·03	10·19	7·92	2·27
7.	13·84	15·23	6·18	3·66	6·59	9·10	7·97	1·13
*8.	12·73	16·56	3·36	3·38	4·06	8·02	...	...
9.	13·84	18·80	3·48	4·55	7·90	9·71	8·02	1·69
10.	13·39	16·56	4·64	5·28	7·68	9·51	8·01	1·50
*11.	12·08	15·09	4·75	4·38	3·73	8·01	...	...
12.	14·27	16·56	7·65	5·51	9·00	10·60	8·12	2·48
13.	13·84	16·29	8·23	5·34	9·66	10·67	8·24	2·43
*14.	11·19	16·03	7·07	3·58	3·95	8·36	...	...
15.	14·27	17·88	6·95	2·89	4·83	9·36	8·36	1·00

* No manure.
† Heavy rain day after sowing. Land flooded; under water for days. Most of the seed killed.
‡ During four months after sowing only ·77 inches rain. Wheat only 3 inches high four months after sowing.
§ Drought.

The preceding table is of special interest as representing the average result of manuring under both favorable and unfavorable conditions. It is sometimes argued against the value of manure experiments that the conditions of the experiment are specially favorable to the action of the manure. This cannot be said in regard to the experiments recorded in the above table. None of the fields were very early sown, two were sown moderately early, and three were very late ; one suffered from flooding, and two suffered from prolonged and almost unprecedented drought ; the balance of the conditions being very much on the unfavorable side.

The averages of the five stations show great regularity, the irregularities of the different individuals almost neutralizing one another in the averages.

The averages of the unmanured plots are 7·92, 7·88, 8·02, 8·01 and 8·36 bushels, the extreme difference being less than half a bushel.

The average effect of the manure is shown in the last column of the table, and may be concisely presented as follows :—

Plot			Caused an average increase of — Bushels.
1.	10 lbs.	concentrated superphosphate per acre ...	2·24
3.	20 „	„ „ „ ...	4·70
5.	30 „	„ „ „ ...	5·33
6.	26 „	ordinary superphosphate (the same amount of phosphoric acid as in Plot 1) per acre	2·27
7.	26 „	Thomas phosphate (containing the same amount of phosphoric acid as in Plot 1) per acre	1·13
9.	10 „	concentrated superphosphate per acre ...	1·69
	20 „	nitrate of soda ... „ ...	
10.	10 „	concentrated superphosphate „ ...	1·50
	40 „	nitrate of soda ... „ ...	
12.	15 „	concentrated superphosphate „ ...	2·48
	60 „	nitrate of soda ... „ ...	
13.	15 „	concentrated superphosphate „ ...	2·43
	46 „	sulphate of ammonia ... „ ...	
15.	39 „	Thomas phosphate ... „ ...	1·00
	60 „	nitrate of soda ... „ ...	

The great regularity of these results is evident. Thus on Plot 1, 10 lbs. concentrated superphosphate caused a growth of 2·24 bushels ; 20 lbs. should therefore have caused 4·48 bushels ; on Plot 3 the actual amount obtained, experimentally, was 4 70 bushels. The heaviest dressing, namely, 30 lbs., was too heavy to come into full action ; in three out of the four cases it produced

no more than the medium dressing, but at Jeparit it had a very fair additional effect, amounting to 1·33 bushels above the medium dressing, and at Berrimal the heavy dressing was proportionately as effective as the light dressing thus :—

	Superphosphate. lbs.	Produced. Bushels.	Each 10 lbs. Producing. Bushels.
Plot 1. Light dressing ...	10 ...	1·34 ...	1·34
„ 3. Medium „ ...	20 ...	3·06 ...	1·72
„ 4. Heavy „ ...	30 ...	4·69 ...	1·63

Each 10 lbs. on the average produced in this case 1·60 bushels. The Mount Pleasant and Jeparit results show that under more favorable conditions, each 10 lbs. could produce more than twice this amount.

Farmers have been afraid of using concentrated superphosphate, because of its high price, £12 10s. per ton, and have not realized that it is a very cheap manure. It is the phosphoric acid in the manure that one has to buy, and all other matter mixed with the phosphoric acid as a rule simply adds to the cost of carriage. There was a little over 4½ lbs. per acre of phosphoric acid given in the form of concentrated superphosphate at a cost, reckoned at Melbourne prices, of 1s. 1½d. per acre to Plot 1, and the result was a gain of 2·24 bushels of wheat per acre. On Plot 6 there was the same amount of phosphoric acid given as ordinary superphosphate, at a cost of 1s. 2d. per acre, and the result was almost identical, namely, 2·27 bushels, the final result being ¼d. per acre in favour of the ordinary, without, however, reckoning the saving in cost of carriage of the concentrated. If the saving in carriage be taken into account the result is about 1d. per acre in favour of the concentrated.

On Plot 7 the same amount of phosphoric acid, at a cost of 1s. 2d. per acre, was given in the form of Thomas phosphate, and the result was a little less than half that obtained from the superphosphate. This agrees closely with English and European experience.

Plots 9, 10, 12, 13, and 15 show the effect of mixing nitrogen with the phosphoric acid manure. Plot 9 received 10 lbs. concentrated superphosphate, the same as Plot 1, but in addition received 20 lbs. nitrate of soda, and the result was a decided decrease in the effect of the phosphoric acid—1·69 bushels instead of 2·24. Plot 10 received twice as much nitrate of soda, with the result that there was a still further decrease in the action of the phosphoric acid. Plot 12 received one-and-a-half times the amount of phosphoric acid that Plots 9 and 10 received, and one-and-a-half times the amount of nitrogen that Plot 10 received, and the result is about one-and-a-half times as great as Plot 9, namely, 2·48 bushels ; one-and-a-half times being 2·52 bushels.

On Plot 13 the same amount of nitrogen was given as on Plot 12, but it was in the form of sulphate of ammonia, instead of nitrate of soda. The result, however, was practically the same, namely, 2·43 bushels as compared with 2·48.

The plots which received nitrogen were in the early stages in advance of the other plots, but fell behind later. The probable explanation is that the more rapid growth on these plots in the early stages resulted in a greater drain on the scanty store of soil moisture, and in the later stages, when owing to their larger size these plants needed more moisture, there was less in the soil for their use.

Plot 15 had the same amount of phosphoric acid and nitrogen as Plot 12, but the phosphoric acid was given as Thomas phosphate, and the result is similar to that already referred to on Plot 7. The result is somewhat less than it should be, apparently owing to an unexplained low yield at the plot in Corack East. If the Corack East plot be omitted, we get the following results :—

Plot 12.	7 lbs. phosphoric acid as concentrated superphosphate and 9½ lbs. nitrogen as nitrate of soda	2·75	bushels wheat.
„ 13.	7 lbs. phosphoric acid as concentrated superphosphate, and 9½ lbs. nitrogen as sulphate of ammonia	2·66	„ „
„ 15.	7 lbs. phosphoric acid as Thomas phosphate and 9½ lbs. nitrogen as nitrate of soda	1·42	„ „

and in this case the proportion is almost exactly the same as between Plots 6 and 7.

REPORT BY THE SCIENTIFIC INSTRUCTOR IN DAIRYING.

(*H. W. Potts.*)

I have the honour to submit my Report for the year 1899.

The courses of technical instruction, with practical demonstrations to managers and others engaged in the dairying industry, have been continued during the past year at suitable centres. Classes assembled at Terang, Koroit, Euroa, Benalla, and Kyneton. The butter season set in early, and in consequence a number of students were unable to leave their factories. Arrrangements were subsequently made through which tuition was imparted to small groups at these factories during suitable evenings. This enabled many to secure the desired training. In all, 47 lectures, with practical demonstrations, were given, with a total attendance of 414.

Apart from the usual course of teaching in milk-testing, estimating acidities, &c., special attention has been given to the subject of dairy bacteriology; the relation of bacteria to butter flavour, taints, and faults; the part they play in the ripening of cream, and the necessity for cleanliness. Pasteurization and its application with the manufacture and uses of "starters" from pure cultures have also been dealt with, also the relative merits of the processes being followed; all of which have an important bearing on the commercial aspect of the industry.

It is very gratifying to report that continued interest is manifested in the work by the students. The attendance is satisfactory and encouraging. The primary object of these courses being to place permanent educational facilities within the reach of all employés associated with our dairying industry, the establishment of a dairy school would meet this, and necessarily provide a more systematic and thorough course of technical instruction.

Increased appreciation is shown by our producers, and those interested in the industry in the popular lectures given on "modern dairying" and its various instructive phases. During the year there have been given 51 lectures, amply illustrated, with an aggregate attendance of 11,913, or an

average of 233·6 per lecture. The initial course of lectures had an average attendance of 51, and those given last year 136.

Technical instruction in our public schools on dairying and allied subjects has been continued during the past year to the children of the fourth, fifth, and sixth classes in the dairying districts.

The children evince a keen and enthusiastic interest in this class of tuition. It inculcates methods of cleanliness and regular habits, and creates an intelligent regard for the principles underlying each practical operation, based upon the observation of the daily facts of rural life.

As a result, this somewhat prosaic avocation assumes a less dreary aspect, and becomes associated with more attractive environment.

Whilst the educational effect is kept in view, the immediate utility of the knowledge imparted to the child is daily apparent in this form of domestic industry.

It is pleasing to note the interest and attention devoted to the work by the teachers.

Thirty-three schools were visited, at which 47 lectures or lessons were given with demonstrations, with a total attendance of 2,649 children, 183 teachers, and 32 parents.

During the course of my work it has been my duty to attend nine agricultural societies' shows to conduct the milk-tests and take part in other dairy sections.

For some time past, the system adopted of estimating a cow's worth as a butter producer, by means of milking contests on the show ground, has been properly subjected to adverse criticism.

The faults are palpable. It is impossible to accurately determine a cow's normal butter yield under the disturbing influences of show-yard conditions. Some change is highly desirable. The plan adopted by the Koroit and Port Fairy Agricultural Societies seems rational and fair. The competing cows are milked at their own homes in the presence of responsible stewards, who weigh the milk and take a proper sample from which to estimate the butter-fat value. This does not interfere with the show, as the animals have all to be exhibited to comply with the conditions of award.

These contests have a marked influence for good. At some of the shows held in the country districts last year, records were made that would do credit to any contest in the world.

During the year I have devoted considerable time to original work under the guidance of Drs. Cherry and Bull, at the Melbourne University, in defining the bacterial milk-flora of the colony, as well as abnormal invasions in our dairy products. Further, the distribution of pure cultures for ripening cream has been taken in hand and instruction given for their use whenever required.

The result of continuous investigation of imported cultures for twelve months is, that we have decided to abandon their use, and distribute freshly-inoculated indigenous cultures. Practical demonstrations have clearly proved the latter to be superior.

In the course of my duties advice is frequently sought by boards of directors relating to alterations, improvements in equipment, methods of manufacture, and varied matters associated with the industry often entailing the submission of lengthy reports. During the past year over 1,000 letters have been written to meet the demands of correspondents. A number of abnormal milks, creams, and butters have been received for examination and report, and a number of tests conducted.

My time has also been largely occupied in attending to duties on the Advisory Board to the Cabinet, the Royal Commission on Technical Education, the Board of Trustees to the Leongatha Labour Colony, and in acting as a judge to award the prizes given by the proprietors of the *Leader* for the best kept dairy farms.

Every opportunity has been seized to come into contact with the producer to tender advice as to breeding, rearing, and culling suitable dairy stock, special feeding, and modern dairy management. In all, 127 farms were visited. Further, 57 butter factories, 29 creameries, and three cheese factories were visited.

In the course of my duties for the year I travelled 18,699 miles by rail, and 1,321 miles by buggy and coach.

REPORT BY THE CHIEF INSPECTOR OF STOCK.

(Geo. Pentland.)

In submitting my Report for the year ending 31st December, 1899, I have the honour to state that the past season has been exceptionally good throughout the colony, and that live stock of all kinds are in a satisfactory condition. There have been no losses such as were felt during the three preceding seasons of drought, and, if we except some slight casualties from actinomycosis, or "lumpy jaw," in the northern portions of the colony, in the early part of the year, it has been a prosperous one, both in regard to the general health of stock, feed, and good prices for stock and wool. Abnormal seasons develop certain ailments in stock, and no country is free from ailments of one kind or other brought about by local conditions. To bring our dairy herds to a higher standard in regard to milk production, I may remark that too much attention cannot be given to feeding, breeding, and provision for comfort and health. Our regulations provide against the introduction of infectious and contagious diseases both by land and sea. The following summary shows the work done by the district inspectors in keeping down disease in cattle within the colony:—

CATTLE.

SUMMARY showing the Number of Dairy and Other Cattle inspected in the Districts, and the number killed and isolated on account of disease, for the Year ending 31st December, 1899:—

Cattle.	Number inspected.	Pleuro-pneumonia.	Tuber-culosis.	Other diseases.	Number killed.	Number isolated.
Dairy ...	87,360	39	151	181	198	170
Other ...	227,008	15	141	93	225	49
Total ...	314,368	54	292	274	423	219

PERCENTAGE OF TUBERCULOSIS.

Cattle.	Number inspected.	Number destroyed.	Percentage.
Dairy	87,360	151	·172
Other	227,008	141	·060
Total	314,368	292	...

From the foregoing it will be seen that out of a total of 314,368 head of cattle, 423 were killed on account of disease, 292 of which were found to be affected with tuberculosis, so that the percentage of tuberculosis is considerably less than that of former years. Since 1893 the attention of the district staff, five in number, has been specially given to the inspection of dairy cattle, and the following figures show the results for the years 1894, 1895, 1896, 1897, and 1898 :—

STATEMENT showing the Number of Dairy and Other Cattle inspected in the Districts, and the number killed and isolated on account of disease, for the years 1894, 1895, 1896, 1897, and 1898.

Year.	Cattle.	Number Inspected.	Pleuro-pneumonia.	Tuberculosis.	Other.	Number killed.	Number isolated.
1894	Dairy ...	119,450	64	315	103	439	48
"	Other ...	194,373	56	276	108	312	128
1895	Dairy ...	108,169	17	325	65	330	39
"	Other ...	236,651	12	269	49	311	23
1896	Dairy ...	120,709	3	320	137	376	75
"	Other ...	245,448	6	229	45	259	24
1897	Dairy ...	102,972	8	270	129	362	143
"	Other ...	227,167	13	182	51	241	5
1898	Dairy ...	91,397	11	220	64	244	217
"	Other ...	257,387	1	237	48	278	4
	Total ...	1,703,723	191	2,643	799	3,152	706

I have frequently reported on the favorable condition of the stock of this colony as regards their freedom from disease, and have made comparisons from foreign statistics. In 1885, statistics taken at the city abattoirs showed that the carcasses slaughtered there were affected in various degrees to the extent of 7 per cent., but later statistics, taken at the same abattoirs during the year 1896, showed 4 per cent., or a reduction of 3 per cent. A return still later from the same source showed that, for twelve months ending 30th June, 1899, the numbers of stock slaughtered and condemned on account of tubercolosis were as follows :—

Bullocks.—34,032 inspected, of which 102 were condemned and destroyed, or about 3 per cent. affected.

Cows.—10,447 inspected, of which 75 were condemned and destroyed, or about 5 per cent. affected.

Calves.—3,935 inspected, one only found affected.

To show clearly the expansion of our stock-breeding interest during the last two decades, full statistical information will be found in appendix marked "A," indicating that this industry is progressive and highly satisfactory. Within that period, horses have nearly doubled in number, namely, from 275,516 to 431,547; milch cows, from 329,198 to 413,278; other cattle, from 957,069 to 1,368,511; sheep, from 10,000,000 to 13,000,000 in round numbers; and pigs, from 241,936 to 337,588. These figures imply that, with increased food production, there is practically no limit to the expansion of our live-stock industry, and that, so long as we are fortunate enough to keep disastrous diseases out of these colonies, we may always count upon our flocks and herds increasing in the same ratio as food-production increases. The worst diseases we have to guard against are glanders, farcy, rinderpest, rabies, foot and mouth disease, catarrh, anthrax, tick fever, &c., all of which are prevalent to a greater or lesser extent in countries and colonies outside Victoria. In this colony we have got rid of scab in sheep, and foot and mouth disease, but we have to guard against their reintroduction, and against swine fever which recently made its appearance in New Zealand and Queensland. Pleuro-pneumonia and tuberculosis are kept in check by the action of this department and stock-owners themselves, so that, so long as our ports and borders are sufficiently guarded, and our inland districts fairly manned, we may safely say that the security of our live-stock industry is assured, and that it will not, we may hope, suffer from controllable causes. In the inland districts the inspectors' attention is more particularly directed to the control of the one or two infectious diseases we have, and much of their time is taken up by special requests made upon them, by dairymen principally, to have their stock examined as to complaints of a non-contagious nature, the outcome of local conditions or of causes arising from abnormal seasons.

With good prices for stock and products of all kinds, our resources are practically inexhaustible, other things being equal.

Inspections of Stock Overland.

Turning to the work done by the inspectorial staff on the borders, the return hereunder shows the numbers of cattle inspected and the numbers found to be infected from

tuberculosis, pleuro-pneumonia, and other diseases, from the year 1891 down to the end of the year 1899. It will thus be seen that, during nine years, 470,479 head of cattle were inspected before introduction, and of this number 1,412 head, or an average of 158 head per year, were refused admission on account of disease of one kind or another :—

STATEMENT showing the number of cattle inspected on the borders and the number refused admission into the colony on account of disease for the years 1891 to 1899 inclusive :—

Year.	Number inspected.	Number found to be affected from—			Number refused admission.
		Tuberculosis.	Pleuro-pneumonia.	Other Diseases.	
1891	128,957	619	53	...	672
1892	69,491	182	10	...	192
1893	43,371	60	15	...	75
1894	39,182	69	15	...	84
1895	35,208	116	...	4	120
1896	35,212	75	...	...	75
1897	46,343	133	23	...	156
1898	30,317	1	4	...	5
1899	42,398	33	...	...	33
	470,479	1,288	120	4	1,412

The crossing places at which stock is introduced on the authority of an inspector of stock are as follows :—Albury, Apsley, Buchan, Cobram, Dartmoor, Delegate, Echuca, Gooramadda, Jingellic, Koondrook, Lockhart, Mildura, Nelson, Penola, Strathdownie, Swan Hill, Tintaldra, Tocumwal, Wahgunyah, and Yarrawonga.

Stock coming from Queensland is only admitted at Wodonga and Echuca, except under special authority.

The above figures show how necessary it is that a staff of inspectors should be kept on the borders to prevent diseased animals in travelling mobs being introduced. We have within the last few years, had occasion to stop some mobs of cattle affected with pleuro-pneumonia until they had been inoculated, and had undergone quarantine restrictions before introduction. It is unfortunate that we have to keep a staff on the borders to prevent the introduction of disease from the stock of our northern neighbours, but this matter cannot well be remedied so long as there is no law in New South Wales dealing with travelling diseased stock, nor

until measures of a suppressive nature have been in force in that colony for such a time as will justify any relaxation of our precautionary policy.

The following table shows the imports of foreign stock which have passed through quarantine before being admitted into this colony for the year ending 31st December, 1899:—

FOREIGN STOCK.

Cattle.	Sheep.	Horses.	Pigs.	Dogs.
—	8	14	7	33

Particulars of the above kinds of stock (quarantined prior to introduction, for the year 1899) are given in Appendix B, and in Appendix C are the numbers of importation of foreign stock commencing from 1879 down to 1893, both inclusive ; —During the years 1894, 1895, 1896, 1897, and 1898, a few importations were treated under the quarantine regulations at Sydney, the numbers of which are also given in Appendix marked C.

Inspections by Sea of Stock Arriving from the Other Colonies.

There is a constant stream of imports by sea, from the other colonies, of single horses and single dogs principally, which arrive by intercolonial vessels at this port. They are accompanied by certificates from inspectors of stock at the port of shipment, and are inspected here and landed in accordance with the regulations. The numbers for the year are as follows:—Horses, 391 ; dogs, 300 ; cattle, 14 ; sheep, 2,503 ; and pigs, 5. The sheep and cattle were introduced principally for stud purposes.

Inspections of Stock Exported by Land and Sea.

As regards stock going out of this colony by land and sea to other colonies and other countries, precautionary measures are adopted in regard to the granting of the certificates required to be produced at the crossing places and at the ports of debarcation. Owners of stock applying for such certificates furnish full particulars to the inspector at the port of Melbourne, or to the inspectors on the borders, as the case may be, and make a statutory declaration as to the antecedents and health of stock about to be sent away. Inspections

are made prior to the granting of such certificates, in the case of cattle and sheep especially, and in this way information is obtained by each colony of all cattle, sheep, horses, and dogs, as to whether such stock is the produce of one or other of the colonies, or has been imported from abroad and passed through quarantine.

NUMBERS of Stock certified to and exported by land and sea to the other colonies for the year ending 31st December, 1899 :—

BY LAND.

Horses.	Cattle.	Sheep.	Pigs.	Dogs.
1,949	8,989	175,173	1,084	...
BY SEA.				
212	954	68,983	748	350

NUMBERS of Stock certified to and exported by sea to countries outside Australasia, for the year ending 31st December, 1899 :—

Horses.	Cattle.	Sheep.	Pigs.	Dogs.
3,040	170	15,816	...	4

On the subject of imports and exports of stock by land I may remark that about 1,000,000 sheep are imported from New South Wales annually, whilst the numbers exported are comparatively small. The excess of imports will readily be understood when we take into consideration the conditions of the export trade in frozen and preserved meats. Importations of sheep from New South Wales are stores and fats, and a large proportion of the latter are killed here specially for export. As regards the numbers of sheep and lambs slaughtered within the colony, the latest statistics from the *Statistical Register* are for 1898, which show that nearly a quarter of a million of carcasses were frozen and preserved for export, and for the year ended 100,000 more is to be added. Meats for export are under the supervision of this branch, and are certified to in accordance with the provisions of the Exported Products Act. A return of live stock slaughtered within the colony for 1898 will be found in Appendix F, which shows the latest numbers obtained of cattle, sheep, and pigs slaughtered for all purposes.

DAIRY CATTLE.

Milk Yields.

Statements having been made that the milk yield per cow in the colony is only on an average 260 gallons per annum, not much more than one-half (500 gallons) yielded per cow in England. I addressed a circular to the district inspectors to report to me the results obtained in their respective districts, of milk yields from cows kept under different conditions.

The conditions were as follows :—

1st. Cows kept under first-rate conditions.
2nd. Cows kept under second-rate conditions.
3rd. Cows kept under inferior conditions.
4th. The breeds and crosses giving the best yields.

On this subject it is important to bear in mind that a cow is simply a machine to be worked in such a manner as will bring profit to the owner without unduly taxing or impairing her producing power.

The reports from the district inspectors are as follow :—

Warrnambool District.

Cows under first-rate conditions ...	600 to 700 gallons.
Cows under second-rate conditions	500 gallons.
Cows under third-rate conditions ...	300 to 400 gallons.

Geelong District.

Information as to exact yields is difficult to obtain, but the average per cow is certainly higher than 260 gallons. The milking season in some districts extends to ten or eleven months, whilst in others from four to five only.

North Gippsland.

Cows under first-rate conditions ...	600 gallons.
Cows under second-rate conditions ...	450 gallons.
Cows under third-rate conditions ...	300 gallons.

South Gippsland.

Daily Yields.

Cows under first-rate conditions ...	2 gallons.
Cows under second-rate conditions ...	$1\frac{1}{4}$ gallons.
Cows under third-rate conditions ...	$\frac{1}{2}$ to $\frac{3}{4}$ gallon.

Inspector Mackenzie, for North Gippsland, remarks that the average obtained in his district is a long way above the average stated to be that of the colony, namely 260 gallons, and that if the dairy herds are properly looked after, the average should not be less than 500 gallons per cow.

Inspector Weir, for South Gippsland, says that it is very hard to get reliable information, as very few farmers keep a record of what each or any cow gives annually. According to the latest return from the *Statistical Register* (1898) the average yield of the whole colony for that year was 260·2 per cow. This return shows the number of dairymen, numbers of dairy stock, and quantity of milk produced on the dairy farms, and will be found useful as a reference to the milk yields of the different districts. See Appendix G.

Best Natural Grasses.

A request was also made to me for information concerning the best natural grasses, and the estimation in which they are held by farmers and graziers as regards their nutritive properties. The information I have obtained on this subject from the districts is as follows :—

Inspector Mackenzie, of North Gippsland, gives first place to the kangaroo grass ; next comes the native barley grass, which is found to be invaluable in the winter time, coming with the first autumn rains, and growing all through the winter, and on the best lands and rich alluvial flats, it will support a beast to the acre. As regards this grass, I may remark that in dry seasons in some parts, it is set down as being a helpful agent in the production of actinomycosis or lumpy jaw, and therefore is not looked upon with favour where this complaint in cattle prevails.

Inspector Haines, of Warrnambool, also says that in his district the kangaroo grass is found to be one of the best of native grasses, and grows fast after rains. In South Gippsland the " tussocky " grass is said, by Inspector Weir, to be the best as a stand-by for the winter months, when English grasses are either withered up or contain very little substance. Nearly all the best native grasses in this district have been eaten off, or their places supplied by imported grasses. It would appear to be very unfortunate that the

kangaroo grass, which grows well on poor or medium soils, and is a good fodder plant in summer months is nearly a thing of the past, nearly eaten out, and that its place in most parts is taken up by a very worthless grass known as the "silver" grass, which only lasts a few months, and is of little or no nutritive value.

Breeding and Feeding.

It is an established fact that the cattle of this colony will compare favorably with the cattle of any part of the world in regard to hardihood and general health. In some parts there are choice herds, well bred, and fed on the best of everything, and these cattle give good returns as already indicated under the heading of milk yields, and cattle kept under "first-rate conditions." The question of breeding and feeding them is one requiring the utmost attention, for no matter how well bred the cow is if she is not properly cared for she cannot give the quality or quantity of milk that she otherwise would give if well nourished. The two things must go hand in hand—good feeding and breeding adaptable to the districts. Finely bred cattle or deep milkers require good treatment. In some districts, however, the bulk of dairy cows are just what poor feeding and impure water have made them. In North Gippsland most dairymen feed their cows during the very dry months of summer, and favour maize, sugar beet, pumpkins, and Cape barley for winter food. Pumpkins are found to be a first-class winter feed, and on the rich flats of Gippsland the yield per acre is enormous. The prices for store and fat stock were very high owing to the scarcity of stock in Queensland and New South Wales and the large amount of dairying in Victoria which has largely superseded fattening. Prices were obtained for stores in many cases which seemed to be unwarranted when compared with those paid for fats. More attention will require to be given to breeding and fattening as well as to dairying, and it would be much better for most owners to keep fewer animals and feed them well from the time they are calves if they desire to have stock of a profitable character.

The cross, generally speaking, that has been found most profitable is that between the Ayrshire and shorthorn both for milk and beef. The Jerseys are good quality cows for milk, but not beef producers. The Jerseys and Ayrshires

are found to be a good milking cross. In different parts of the colony we require different breeds suitable to the varied circumstances of each district as in Great Britain. The shorthorn and the crosses therefrom are found to do well in country where the pasture is good and where there is no scarcity of artificial feeding. For hardihood in times of adversity, I believe one of the coming breeds is the Kerry, and this breed, I am of opinion, will be found in our dry districts before long. What is wanted in such country is a cow that can live under extremes of heat and cold, hardy in constitution, and such an animal we have in the Kerry. It is said that the Kerry is the poor man's cow, and gives more milk in proportion to live weight than any other breed in the world. I have it on good authority that this breed does well in the hot dry districts of Queensland, giving excellent yields of milk both in quality and quantity. In connexion with suitable breeds and crosses, one of the chief drawbacks to raising the general standard of our herds will always be the want of care on the part of dairy farmers in the rearing of their calves for milkers. In many parts calves are weaned at three months old, and turned into miserable paddocks or on the roadsides to live or die, and these in time become cows with no stamina or constitution or anything else to recommend them. There is much to be done in the way of rearing young suitable dairy stock before the standard of our milk production can be materially raised. Many dairymen, however, see the advantage of culling from their herds unprofitable cows eating good food, and a policy of this kind, universally acted on, would soon raise the average yield per cow.

Special Mortality.

A number of deaths occurred in many parts of the colony from milk fever, especially in the Camperdown district, owing to the exceptionally good season for grass. Preventive measures were recommended in those cases that came specially under notice. About six weeks or two months before calving, it is advisable, where there are rich pastures, to remove cows to paddocks containing less grass, so as to prevent plethora or a superabundant formation of milk. The veterinary treatment consists of, in the main, the injection of an antiseptic fluid into the udder by the milk-fever syringe, and washing the cow carefully out with Condy's fluid. On

the other hand, a good season, with plenty of succulent grass and herbage, has the effect of reducing the percentage of "cripples" usually found in adverse seasons ; but in poor or inferior country, when the grass dries up rapidly, this complaint is liable to make its appearance.

Pleuro-pneumonia has been in evidence this year more so than in former years, more particularly in the Western and Gippsland districts. The outbreaks in each case were no doubt the outcome of the change of seasons, but, having been brought under the control of the district inspectors, were got under by the destruction of affected animals, and the inoculation and isolation of the others. In one case inoculation was very indifferently performed, the operator having little or no skill or experience either in the selection of proper virus or the method of operating, and some deaths are said to have occurred in consequence. On this subject, instructions for inoculating for pleuro-pneumonia will be found in a paper read by me before the Tatura Agricultural Society in July last. See Appendix H.

Diseased Udders.

Very few cases of tuberculosis cows show tuberculosis in the udder when the milk is professionally examined. There are a great many affected with mammitis and other inflammations arising from different causes. Some cows are blind in one quarter only, and others in two, and odd ones in even three. If attended to in time, these udder troubles are reduced by treatment—hot fomentations and rubbing with castor oil, or camphor and lard have been found beneficial. Udder trouble is more prevalent in very good springs when there is a great flush of pasture from damp, cold, camping grounds, and from injuries sustained by blows, or by a horn from another beast. Another complaint is a growth inside the teat, which stops the flow of milk, but this is readily cured by passing in a teat syphon.

Sheep.

There has been no special mortality in sheep, and the lambing has been the best for years, so that the losses in the dry seasons will soon be made good. The number of sheep in the colony may fairly be estimated at between 12,000,000 and 13,000,000 as against 13,180,943 returned for the year 1895.

The result of the inspections made by the district inspectors shows the condition of our sheep to be highly satisfactory, whilst the good prices both for sheep and lambs for freezing and local consumption have been the means of creating an unusual demand for store stock at exceptionally high prices. The great advance in value of merino wools has given a considerable impetus to the wool-growing industry, and it is to be earnestly hoped that this prosperity may long continue. In the North Gippsland district more particularly, the numbers of sheep have greatly increased during the last few years; farmers with poor land now find out that it pays them better to keep sheep than breed cattle, and the more attention they give to the improvement of their lands the better the returns. The Victorian clip for 1899 shows an increased value of something like £1,500,000 as against previous years. The total value of the year's clip is estimated at £3,464,500, whilst the value of the clip of 1898 is set down at £1,716,000. The better season and better prices of 1899 are to be credited with this highly satisfactory state of things. The numbers of sheep inspected in the districts by the inspectors, in connexion with their other duties for the year, is about 500,000 in round numbers. This is exclusive of sheep inspected before and after slaughter at the freezing and preserving works at Melbourne, Geelong, and Portland.

BOTANIC GARDENS

Diseases.

Reports from the districts show that parasitic diseases have not been prevalent—fluke, worms, foot-rot, lice, and ticks have not been troublesome.

Abscesses.

A comparatively new disease to these colonies in sheep has been brought under notice within the last five years in the form of abscesses in sheep. It is a bacterial disease, and is confined to certain localities or stations which favour its retention and development. It does not affect the general health of sheep, and some of the primest animals are the worst affected. It is not a contagious disease in the ordinary sense, but is conveyed through the medium of cuts and wounds, &c., and the contagium is derived from the soil. The lymphatic glandular system is attacked, and swellings occur, varying in size from a peanut to a hen's egg, so that

it is difficult to detect the disease until after slaughter, although its existence may be ascertained in the living animal by manipulation. The contents of the tumours are yellowish green in colour, and fluidic in consistency. Dr. Preisz, in Buda Pesth, Hungary, describes a bacillus identical with that which occasions this disease, which he called pseudo, or false, tuberculosis, from its resemblance to true tuberculosis. Further inquiries will be made by the district inspectors as to whether it is spreading in the localities wherein it now exists, and also as to the best methods of coping with it. Carcasses showing abscesses in an advanced stage are rejected, and not allowed to go into human consumption.

Anthrax.

In the early part of the year there were two outbreaks of anthrax which were promptly suppressed, and there has been no further appearance of the disease. The new regulations providing against the introduction of anthrax from New South Wales have had the effect of preventing stock that have travelled over anthrax areas being introduced, but, nevertheless, we shall always be liable to get anthrax from across the border whilst diseased stock are allowed to travel in that colony. These regulations will be found in Appendix I.

Now that good prices are being obtained for both wool and mutton, greater attention must necessarily be given to securing the most suitable breeds of sheep. Local conditions will largely determine the kinds most suitable either for breeding or fattening, whilst at the same time it must be remembered that animals of sound constitution pay best. We have exceptionally fine sheep in merinos, longwools, shropshires, downs and other breeds, and farmers and graziers have done well in sheep in every direction ; and lambs this season have been exported by the Geelong Freezing Company in considerable numbers, so that so long as we have good seasons the export trade in lambs will be a profitable one at present or higher prices.

The dips used are various. The arsenic or home-made dip is largely used in the western district, whilst many others prefer Cooper's, Quibbel's, Little's, Lawe's, and others, most of which have been in use here for many years, for the destruction of ticks, lice, &c.

As regards the arsenic dip, the quantities are ¼ to ⅜ oz. to a gallon of water, with ⅜ oz. of pot. carb. (pearlash) added, and a solution of arsenic and soft soap is often used by flock-owners.

Since the eradication of scab the district staff has had comparatively little to do in the supervision of sheep; owners themselves generally adopting the best methods of treatment when occasion arises. The diseases of fluke, worms, footrot, ticks, and lice are matters which can be better controlled by owners than by any interference on the part of the State. Some owners, however, who constantly dip after shearing to keep down parasitic diseases favour compulsory dipping, in order that smaller owners who do not care to go to the expense of dipping their comparatively few sheep may be obliged to dip also. Other large owners go so far as to express their willingness to provide accommodation for neighbours dipping so as to insure protection against re-infection. If dipping were made compulsory, the district staff would require to be considerably increased, so as to insure the regulations being uniformly carried out.

HORSES.

Diseases.

Horse stock continue remarkably free from disease, only now and again has a case of stringhalt cropped up in the districts. This complaint disappears in the good seasons and certain localities are notable for its recurrence in times of drought and scarcity of nutritive food and pure water. The bot-fly made its appearance in some parts, but the losses from this cause and from strangles are reported to be very light. Our importations of high-class horses are somewhat limited, twelve head in all, consisting of seven blood stallions, three mares, and two draught stallions, there being little or no demand made by breeders or small land-owners to secure the services of the superior sires we already have in the colony. Since the year 1891 the number of stud horses imported from countries beyond Australasia is 240, as shown in Appendix D. Our regulations provide against the importation of the dreaded diseases of glanders and farcy which, I am happy to say, are unknown to Australasia;

horses, imported from countries outside the colonies, have to undergo a quarantine of fourteen days, and, at the end of that time, if certified to by an approved veterinarian and an inspector of stock, they are then released. We have everything in our favour as regards the extension of the horse industry—climate and freedom from disease.

Breeding.

The great thinning out of our best mares to India and other places has had a very injurious effect on the breeding quality of our horses, and until some measure of reform is adopted, our export trade in the future may not be so good as in the past. We have high-class sires of all kinds, but breeders will not pay for the services of a stallion of high repute, no matter whether thoroughbred or otherwise, consequently when inferior sires mate with inferior mares, the result is disappointment. How to overcome this state of things involves the wholesale condemnation of inferior or worthless animals, but how to carry this idea out, if owners are indifferent, is another matter. The common sense of owners themselves must prevail for it would be much better to cease breeding altogether, than have useless horses of no value whatever. The average number of horses shipped during the preceding six years to India, Mauritius, and the Straits Settlements was about 4,000 in round numbers, whilst for the year just ended 3,040 were shipped to these countries. This is a shortage of nearly 1,000, and from this fact it would appear that owners are only standing in their own light in breeding from inferior stock. Of late years, breeders have lost very heavily for the want of giving attention to the principles of breeding, and it is not for the want of knowing better that they do not improve their stock as they should, for the low prices in most cases obtained, and sometimés no sale, is certainly a matter that touches their pockets. It is to be hoped most breeders will see this in time; the remedy being to have weedy animals at once shot, and their places supplied by more desirable stock.

My pamphlet on the subject of horse breeding treats of cheap inferior stallions being an evil, and recommends that a registration fee should be imposed on all stallions; and this, in effect, means either a tax or licence. The other matters treated of are—Influence of the dam, cross breeding,

the Arab, English coaching or roadster breeds, Victoria eminently suitable for horse breeding, and the extension of the export trade. (See Appendix J.)

PIGS.

This class of stock is remarkably healthy, no unusual mortality being reported. The regulations in force guard against the introduction of swine fever from New Zealand and Queensland, on account of recent outbreaks of that disease. Our pigs, I am glad to say, are remarkably free from infectious and contagious diseases. Two importations of Tamworths from England passed through quarantine during the year. This breed is looked upon as one of the best to cross with the Berkshire, the meat of the produce being lean or streaky.

The pig industry is one of the chief adjuncts of the dairy farmer, and there should be no difficulty in cultivating a payable trade with our friends at home, seeing that prices are now sufficiently good to enable this to be done. There has been a steady increase in the numbers of pigs from the year 1881 down to the year 1885 (see Appendix A), but of late years no returns have been obtained. This industry will make further strides with the advance of prices.

DOGS.

The number of dogs imported and quarantined during the year was 33 of various breeds as shown in Appendix E. During the last ten years importations have been much at the same rate, and a marked improvement has been affected by the introduction of some of the best breeds. High prices of late years have been paid for all kinds of pure-bred dogs, and it is satisfactory to know that we have in recent times imported some of the best dogs to be found in the old country. The disease we have to guard against is rabies, a very fatal disease to man and beast, and is of long incubation, six months' quarantine being imposed. I am glad to say that no signs of this malady have ever manifested themselves in any of our importations ; the regulations having, with few exceptions, been strictly complied with.

POULTRY.

Regulations providing against the introduction of infectious and contagious diseases in poultry have been carried out both by land and sea. Owners desirous of introducing poultry are required to give an inspector of stock 48 hours' notice in writing and make a declaration as to their freedom from argads or ticks. Ticks have been found in poultry in the lower parts of the Murray, but not in great numbers. About the months of March and April the diseases roup and diphtheria cause some trouble in certain localities where proper preventive measures are not taken in time. It is to be hoped that a lucrative export trade will shortly spring up in poultry. Regulations on the subject of poultry disease are contained in Appendix K.

BRANDING STOCK.

Some attention has been directed of late to this subject, on account of cattle, sheep, and horse stealing in some parts necessitating a law to prevent such nefarious practices. An effective measure for this purpose would require to be founded on an elaborate system of registration, involving considerable expenditure in carrying out its penal provisions. As regards the Branding Acts of the other colonies, I may repeat that the circumstances of this colony are altogether different from those of its neighbours, where holdings are much larger, and where stock do not change hands so often; so that, to carry out a measure of this kind would entail a material increase of the staff, and provision would have to be made for an annual registration fee on the stock-owners, or an increase in our annual vote. It would be impossible for the district staff, consisting of only five inspectors, to carry on the work of registration, dairy inspection, and their other duties, their districts being so large.

PAPERS ON DISEASES IN STOCK.

During the year I read papers on diseases in stock before the Agricultural Societies of Shepparton and Tatura respectively, as also before the Butter Factories Managers' Association. I pointed out that the disease we had chiefly to deal with is tuberculosis, and that the staff is actively

engaged in preventing the introduction and spread of this and other infectious diseases in stock. Doubtful cases of tuberculosis are isolated, as a rule, whilst in some instances we have had recourse to the tuberculin test, but this method is a slow and tedious one as compared with the destruction of visibly affected animals, or what may be termed "*taking the rough off the herds.*" During the last six years about 3,000 beasts suffering from tuberculosis, and 1,318 from pleuro-pneumonia and other diseases, have been destroyed, under supervision, in the country districts and at the market yards, showing an average of 120 head destroyed by each officer, which is a fairly good record when it is considered that long distances, as a rule, have to be travelled in all parts of the colony to get at individual diseased beasts.

For applying the tuberculin test, instructions are given in Appendix L, and for inoculating for pleuro-pneumonia, instructions are also given in Appendix F. When we compare our small percentage of tuberculosis in our herds with that of other countries we have to compete against in exported produce, Victoria certainly stands in a most favourable position, but it behoves all concerned to strive earnestly to get rid of the comparatively little disease that remains, and to keep out all disastrous diseases by adopting every possible precaution.

Tick, or Texas Fever.

This disastrous disease threatens the cattle industry of these colonies, it having already done much damage in Queensland. New South Wales is very anxious to keep it out by every possible means that can be adopted, and that colony cannot be too strict in the enforcement of regulations affecting the introduction of Queensland stock. The coastal country is the most dangerous, and here the greatest risk lies, so that neither New South Wales nor Victoria can afford to relax the restrictions now imposed by land and sea, as the safety of both colonies will depend upon the maintenance of proper precautions. It is to be hoped that we shall be prepared to meet the enemy, should an invasion unfortunately take place, by the best methods of inoculation and dipping, and that the efforts now being made by Queensland to determine by experiment the value of present methods, and of improvements when required, will be rewarded with success. The whole pastoralist community is deeply

concerned as to the real value of inoculation, seeing that inoculated cattle (clean cattle before inoculation) carry in their systems the micro-organisms of the fever which are conveyed by non-pathogenic ticks, or other morbific agents, to clean cattle, which then become affected with tick fever.

Our existing regulations prohibit the admission of all Queensland stock by sea, and the conditions upon which such stock is admitted by land are as follows :—Cattle, sheep, and horses have to undergo a probationary period of three months in New South Wales ; both horses and dogs stabled and groomed are admitted on one month's probation ; West Australian stock is prohibited.

In conclusion, I think it important to add that the vast amount of work the Department is now required to attend to, justifies me in again calling attention to the fact that the districts are far too large and unwieldy, and require to be cut up into smaller areas in order that closer and more constant inspections may be made. The dairying industry has been, and is, a growing one, and better provision is required than there is at present, for overtaking the work by the appointment of additional inspectors.

APPENDICES.

A. Live Stock in Victoria, 1881 to 1899.
B. Number of Foreign Stock imported for 1899.
C. Particulars of Foreign Cattle and Sheep imported from 1879 to 1893; and from 1893 to 1900 of Cattle, Sheep, Pigs, and Dogs imported. but quarantined in Sydney.
D. Number of Horses imported and quarantined, 1891–99.
E. List of Dogs imported from Great Britain, 1899.
F. Return of Live Stock slaughtered in Victoria, 1898.
G. Return of Dairymen, Cows, and Milk Production, 1898.
H. Paper read before the Tatura Agricultural Society.
I. Regulations providing against Anthrax.
J. Horse-breeding Pamphlet, No. 42.
K. Poultry Regulations.
L. Paper read before Shepparton Agricultural Society.

APPENDIX A.

LIVE STOCK.—1881 TO 1899.—(Statistical Register.)

Year ended March.	Number of Live Stock.						
	Horses.	Cattle.			Sheep.	Pigs.	Total.
		Milch Cows.	Exclusive of Milch Cows.	Total.			
1881* ..	275,516	329,198	957,069	1,286,267	10,360,285	241,936	12,164,004
1891* ..	436,469	395,192	1,387,689	1,782,881	12,692,843	282,457	15,194,650
1892 ..	440,696	405,973	1,406,131	1,812,104	12,928,148	286,780	15.467,728
1893 ..	439,596	417,177	1,407,527	1,824,704	12,965,306	290,339	15,519,945
1894 ..	436,903	431,962	1,385,329	1,817,291	13,098,725	328,162	15,681,081
1895 ..	431,547	465,389	1,368,511	1,833,900	13,180,943	337,588	15,783,978
1896 ..	..	462,578†	..	..	..	..	..
1897 ..	..	457,924†	..	..	..	..	..
1898 ..	..	399,617†	..	..	..	..	..
1899 ..	..	413,278†	..	..	..	‡	..

NOTE.—For returns for each municipality see Census of 1891, or page 620 of the Statistical Register for 1890.

* Census years. Complete returns of live stock are only furnished in Census years, but it was customary prior to 1896 to estimate the numbers for intercensal years by adding on, or deducting from, the numbers as returned by the last Census, an increase or decrease, as the case might be, based on estimated percentages furnished by the municipal authorities. As, however, this method was found most unreliable, it has been decided to abandon it.

† On agricultural and dairy farms only.

‡ For number on farms, see preceding table.

APPENDIX B.

PARTICULARS of Foreign Stock imported from Great Britain and quarantined, for the Year ending 31st December, 1899.

SHEEP.

Date.	Owner.	Address.	No.	Sex.	Description.
1899. December 15	R. S. Wilson and Co.	Melbourne	8	6 rams 2 ewes	Shropshires

PIGS.

Date.	Owner.	Address.	No.	Sex.	Description.
1899. March 30	G. T. Chirnside	Werribee...	4	Mixed	Tamworth
September 5	J. P. Chirnside	Werribee...	3	Mixed	Tamworth
		Total ...	7		

APPENDIX C.

NUMBER of Foreign Stock imported from 1879 to 1893.

CATTLE.			SHEEP.		
Bulls	...	38	Rams	...	73
Cows	...	60	Ewes	...	160
Heifers	...	53	Lambs	...	6
Calves	...	16			

STOCK from Other Countries for owners in Victoria quarantined in Sydney, from 1st January, 1893, to 10th January, 1900.

Horses	...	1	Pigs	...	*Nil*
Cattle	...	12	Dogs	...	12
Sheep	...	13			

APPENDIX D.

NUMBERS of HORSES imported and quarantined, from January, 1891, to December, 1899.

Blood ...	Stallions	55
	Mares	43
Draught	Stallions	28
	Mares	*Nil*
Other		114

APPENDIX E.

LIST OF DOGS imported from Great Britain and quarantined, for the Year ending 31st December, 1899.

Date.	Owner.	Address.	No.	Sex.	Description.
1899.					
Feb. 14	H. J. Mills ...	South Yarra	1	M	Japanese spaniel
Mar. 22	H. A. Woolnough	Mentone ...	2	M	Bull dogs
April 25	Rd. Chugg ...	Canterbury	1	M	Black and tan terrier
May 1	M. D. McEachern	Balaclava ...	2	F	Japanese spaniels
,, 8	W. Beilby ...	South Yarra	1	...	Fox terrier
,, 8	E. N. Twopenny...	South Yarra	1	F	Fox terrier
,, 8	A. C. Mills ...	South Yarra	1	M	Scotch terrier
,, 20	D. J. Gilchrist ...	Moonee Ponds	1	F	Yorkshire terrier
June 19	Abel Webb ...	Malvern ...	1	F	Greyhound
,, 21	J. D. Pinkerton ...	Spencer-street	1	F	Poodle
July 5	Wilson Bros. ...	Ercildoune...	1	M	Fox terrier
,, 17	Clive Gaunt ...	Windsor ...	1	F	Airedale terrier
,, 22	L. D. Borsdorff ...	Brighton ...	2	M	Collies
,, 24	Chas. Ridley ...	Northcote ...	1	F	St. Bernard
,, 24	Melb. Hunt Club	Oakleigh ...	1	M	Fox hound
Aug. 17	Oaklands Hunt Club	Oaklands ...	7	Mxd	Fox hounds
,, 29	Prof. Harper ...	Malvern ..	1	M	Dandi Dinmont
,, 31	D. McGregor ...	Coburg ...	2	M	Collies
Oct. 10	F. Dewey ...	Kensington	1	F	Fox terrier
Nov. 22	J. K. Forrest ...	St. Kilda ...	1	M	Skye terrier
,, 29	Miss Sturt ...	Collins-street	1	F	Fox terrier
Dec. 19	W. P. Wilkinson	North Carlton	2	Mxd	Chow dogs
		Total ...	33		

APPENDIX F.

LIVE STOCK SLAUGHTERED.

RETURN showing the Number of Live Stock Slaughtered in the Colony of Victoria during the Year 1898 (Statistical Register).

Description of Live Stock.	Numbers Slaughtered for—				Total Number.
	The Butcher and Private Use.	Freezing.	Preserving or Salting.	Boiling Down for Tallow or Lard.	
Sheep—					
Sheep	1,679,826	159,405	22,520	10,867	1,872,618
Lambs	355,337	56,234	...	1,014	412,585
Sheep and Lambs (not distinguished)	67,491	...	...	...	67,491
Total ...	2,102,654	215,639	22,520	11,881	2,352,694
Cattle—					
Bullocks	128,329	88	60	41	128,518
Cows	78,819	29	85	321	79,254
Calves	30,908	24	443	15	31,390
Cattle (not distinguished)	5,157	...	...	...	5,157
Total ...	243,213	141	588	377	244,319
Pigs	77,596	1,020	85,884	5	164,505

APPENDIX G.

(From Statistical Register of Victoria.)

COW-KEEPERS, DAIRY CATTLE, PIGS, AND MILK PRODUCED.

RETURN showing the Number of Cow-keepers, Milch Cows, Calves, Pigs, and Milk produced on Agricultural and Dairy Farms for the Year 1898.

District and County.	Cow-keepers.	Cows and Heifers in Milk or in Calf.		Calves (under 12 months).	Pigs.	Milk Produced during the Year.		Number of Cream Separators used on Farms.
		Total Number	Number whose Milk was recorded.			Quantity returned.*	Average per Cow.	
Central District—						galls.	galls.	
Mornington	1,005	21,651	16,574	8,071	4,893	3,752,990	226·4	356
Evelyn ..	576	8,289	3,789	2,417	1,877	836,541	220·8	44
Bourke ..	2,745	33,754	19,634	7,683	5,534	5,842,479	297·6	172
Grant ..	1,735	16,830	7,417	5,677	5,736	1,931,522	260·4	83

Cow-keepers, Dairy Cattle, Pigs, and Milk Produced—*continued.*

Return showing the Number of Cow-keepers, Milch Cows, &c.—*continued.*

District and County.	Cow-keepers.	Cows and Heifers in Milk or in Calf.		Calves (under 12 months).	Pigs.	Milk produced during the Year.		Number of Cream Separators used on Farms.
		Total Number.	Number whose Milk was recorded.			Quantity returned.*	Average per Cow.	
North-Central District—								
Anglesey ..	296	10,765	9,291	4,946	3,090	2,057,299	221·4	49
Dalhousie ..	1,093	14,938	8,079	6,683	4,437	1,776,197	219·9	59
Talbot ..	1,902	14,288	7,524	6,611	4,408	1,749,183	232·5	103
Western District—								
Grenville ..	775	9,780	5,573	3,048	3,014	1,894,007	339·9	27
Polwarth ..	490	9,332	7,148	3,370	4,245	2,236,631	312·9	41
Heytesbury	501	15,306	13,332	3,994	5,281	3,648,056	273·6	5
Hampden ..	352	19,926	17,052	3,633	5,269	5,506,985	323·0	1
Ripon ..	378	2,347	197	1,007	901	39,033	202·7	6
Villiers ..	935	17,507	11,885	5,095	6,743	3,776,155	317·7	5
Normanby ..	567	5,523	3,917	2,762	1,233	762,057	194·6	10
Dundas ..	242	1,592	708	852	493	155,801	220·1	3
Follett ..	66	382	37	240	260	5,032	136·0	..
Wimmera District—								
Lowan ..	1,078	4,041	328	2,500	3,255	92,786	282·9	3
Borung ..	1,500	7,860	836	4,366	3,012	152,047	181·9	38
Kara Kara ..	959	6,209	989	3,405	2,340	219,055	221·5	12
Mallee District—								..
Millewa ..	..	..	..	..	..	..	..	..
Weeah ..	26	54	..	30	69	..	..	..
Karkarooc ..	92	538	..	340	509	..	..	..
Tatchera ..	480	4,704	2,885	2,333	1,470	859,179	297·8	55
Northern District—								
Gunbower ..	589	9,373	6,972	5,334	2,486	2,269,826	325·6	231
Gladstone ..	745	5,312	2,179	3,074	1,650	402,838	184·9	19
Bendigo ..	1,276	10,446	3,246	5,293	3,846	806,653	248·5	46
Rodney ..	1,067	12,078	6,101	7,493	5,497	1,499,302	245·7	114
Moira ..	2,633	44,951	20,004	20,814	15,845	4,061,254	203·0	261
North-East District—								
Delatite ..	1,117	23,053	10,603	10,508	5,557	2,598,008	245·0	46
Bogong ..	1,1·5	12,405	4,554	8,036	5,408	1,091,122	239·6	36
Benambra ..	351	5,451	3,827	4,846	2,777	845,485	220·9	14
Wonnangatta	74	1,405	689	975	783	149,472	216·9	6
Gippsland District—								
Croajingolong	111	1,736	187	1,368	2,986	41,001	219·3	5
Tambo ..	104	1,321	617	1,024	2,162	118,292	191·7	9
Dargo ..	132	2,588	1,221	1,673	1,602	393,466	322·2	7
Tanjil ..	691	15,330	10,121	8,722	8,196	3,322,303	328·3	58
Buln Buln ..	1,765	42,213	31,002	20,984	16,802	7,163,217	231·1	875
	29,633	413,278	238,518	179,207	143,666	62,056,174†	260·2	2,799

Note.—In 44 urban municipalities 2,074 dairies, and in 56 shires 2,834 dairies were reported to have been registered, but in the remainder the system of registering does not appear to have been adopted. All but 1,317 of the cow-keepers were also cultivators, and form part of the 39,877 cultivators as shown in the Agricultural Statistics, *ante*.

* Many of the farmers could not supply the information.

† Applying the average of 260·2 to all the cows, the total milk yield in 1898 of the agricultural and dairy farms of the colony, which have been returned, may be put down at about 107,535,000 gallons, as against 103,980,000 in 1897 (260·2 per cow), 116,166,000 in 1896 (253·7 per cow), and 109,200,000 in 1895 (236 per cow). It should be mentioned that in 1895 and 1896 the basis was "milch cows, wet and dry," and in 1897 and 1898 "cows and heifers in milk or in calf." The yield of private cows, &c., is not taken into account.

APPENDIX H.

DISEASES IN STOCK.

By G. Pentland, Chief Inspector of Stock.

Read before the Tatura Agricultural Society.

Bovine Tuberculosis.

I may say that it is most satisfactory to find that we have a lower percentage of this disease than any other stock-raising country in the world. I have had frequently to report on this subject, and I am pleased to say that recent events have verified the conclusions arrived at by the committee of Victorian experts appointed in 1883 to investigate this disease. This committee consisted of Dr. Plummer (chairman), the Hon. James Buchanan, M.L.C., the Hon. J. L. Dow, Professor Allan, M.D., and Dr. Jameson, M.D., and your humble servant now before you, as their secretary. These gentlemen reported in the years 1884–5 that all cattle slaughtered for the meat supply of Melbourne were tuberculous in some degree, probably to the extent of 7 per cent. Ten years afterwards fresh statistics were taken, showing that only 4 per cent. of all cattle were affected, a decrease of 3 per cent. It was stated, however, that more diseased cattle were slaughtered at Braybrook, one of the suburbs, and that it was possible that the percentage would be greater when so many private slaughter-yards were not subjected to the same rigid inspection as at the city abattoirs. A special and duly qualified officer was appointed by the Braybrook Shire Council to report on this matter, who found that, in the cattle slaughtered there, the percentage was not any more than at the city abattoirs. I may here point out that of this 4 percentage only one (1) per cent. is condemned by the health authorities, the condemnations being mainly confined to generalized and not localized tuberculosis.

Regarding dairy cattle, the latest statistics show that, under the tuberculin test of certain herds, 9 per cent. has been obtained, and I may here observe that the bulk of these herds were, as far as I can understand, living largely under artificial conditions, both in regard to feeding and housing, and, as a consequence, a larger percentage obtains in cattle living under such conditions. Dairy herds in another part of the colony have been tested by a specialist, with the result that no tuberculosis was found, so that it matters very little for the present any conclusion that may be drawn as to the exact percentage, seeing that the status of our

dairy herds, at the worst, is far and away superior to that of any other country that we have to compete against in our exports of dairy produce, as I shall endeavour to show further on. The good work done in the suppression of tuberculosis in the past by the inspectors in the country districts, and at the principal market yards of the colony, has had an educational effect in checking the spread of this disease, inasmuch as stock-owners know that it is to their own personal advantage to get rid of disease of any kind as speedily as possible. Every tuberculous beast destroyed is one centre of contagion the less, and since tuberculosis was placed on the schedule of contagious diseases a vast amount of contagion has been got rid of by the district and border inspectors of stock, whilst it may be added that stock-owners themselves get rid of a very considerable amount in their own interests. This general riddance of known centres of contagion would not have been obtained so quickly had it not been for the recommendations of the Victorian committee of experts already referred to, whose wise advice in many ways has been carried out for many years by this Department and stock-owners themselves. This colony was one of the first countries in the world to have legislation on this subject, and the dairying industry is now reaping the benefit; stock-owners are now generally well acquainted with symptoms and *post-mortem* appearances, and every day their experience is enlarged in the general riddance of this enemy of both man and beast.

From statistics of the leading countries in Europe we find that the percentage of tuberculosis is very much greater than in this colony, as for instance in Saxony in 1893, at the abattoirs, there was 18·26 per cent. and in 1895 27·48 per cent., whilst in Copenhagen the increase was from 16·60 per cent. in 1891 to 29·45 in 1895, England 22 per cent. and upwards, France 25 per cent., but some districts of that country are entirely free from tuberculosis. In the close ill-ventilated byres of London and Edinburgh as much as 60 to 70 per cent. has been found. Our dairy cattle live in the open air, hence their comparative freedom from infectious disease of any kind. It will be remembered that not long ago some alarmists, through the metropolitan public press and in other ways, gave it out that our cattle were the worst of any civilized part of the globe, and harsh things were said of the stock inspectors. These people, as is well known, have, I am glad to say, proved themselves to be thoroughly unreliable, and their statements fallacious. I publicly contradicted these damaging statements at the time they were made, both in the press and in my official reports, and the opinion I then held as to the comparative freedom from disease of our dairy herds has long since been borne out by facts.

Lessening Tuberculosis.

The question of how to get rid of tuberculosis is a very large one indeed, as well as a vital one, and attention to this subject is now being directed by the authorities of New South Wales, a commission of inquiry having been appointed to investigate this and other diseases in stock. It is fortunate that action in this direction is now being taken by that colony, and that stock diseases are likely to be dealt with in an effective manner; that New South Wales inspectors will, it is to be hoped, eventually have power to inspect and deal with travelling stock coming up to our borders, and so prevent the travelling of diseased cattle and sheep intended for this colony. This is one of the first essentials so necessary in getting rid of what disease we have, namely, that action on the part of our neighbour should be sharp, decisive, and effective. In addition to this, it will be well to bear in mind that tuberculosis is not likely to be got rid of whilst it exists in the human race, and it seems to me that much can be effected in the direction of lessening the spread of tuberculosis from man to man, as well as from animal to man, and so far as I can learn, the bulk of tuberculosis in mankind is not so much due to the products of tuberculous animals as to the way in which mankind live, especially in large centres of population. The close association of mankind and insanitary surroundings are undoubtedly largely responsible for the amount of tuberculosis we have in the human family. One in seven deaths is the death rate, *i.e.*, 14 per cent. of human beings die from tuberculosis, otherwise termed consumption, while the cattle in this colony are only affected in various degrees, to the extent of only one-half that percentage at the outside. Our cattle, then, are certainly freer from tuberculosis than mankind, and of this percentage we have no idea of how many would recover and in how many the disease would make no further progress. It may here be stated that it is a singular fact that a consumptive dairyman or farm servant is rarely seen.

Tuberculin Test.

Conclusions arrived at by investigators.—The difficulty in dealing with tuberculosis in cattle is the unseen and unknown quantity to contend with, the inability of the tuberculin test to give the exact extent of the disease, and whether such disease might remain in the system of the beast harmless for the remainder of its life or not. Inquiries of this kind were instituted by the state of Vermont some four years ago, and the conclusions arrived at, I think, are up to date and are as follows:—

1. The temperature of healthy animals and those affected with a disease other than tuberculosis rises after the injection of

tuberculin. 2. Some tuberculous animals do not react to tuberculin. 3. Tuberculin does not determine the stage of the disease, but condemns animals that might live for years and possibly recover. 4. Tuberculin may produce the disease in healthy animals, and certainly hastens its progress in those affected. 5. Any test to be effective must be followed by the slaughtering of the animal if the presence of the disease is indicated.

These conclusions have since been verified by other observers, the most recent being Friedberger and Frohner, who say that tuberculin is not a specific diagnostic agent for tuberculosis, and that it performs a similar object for the strepticocci of pus and other micro-organisms; that, as it is not a specific diagnostic agent, its reaction cannot be accepted as a positive proof of the presence of tuberculosis. They, however, say that it may be used with advantage under certain circumstances. It is further pointed out that failures in diagnosis have been estimated at 15 per cent. in Germany and at 4 per cent. in Denmark, and we learn also that, in the recent case of Her Majesty's herd at Windsor, the tuberculin test did not prove to be infallible, although its value as a diagnostic agent cannot be disputed, *if sacrifices are no object monetarily*, for we are told that the 40 cows forming the herd were all in good condition, and apparently healthy. Thirty-two of the 40 cows reacted, their temperatures rising to 104 deg. Fahr. or more, whilst 5 appeared to be healthy and 3 doubtful. The whole herd was killed, and it was found that of the 34 animals, whose temperature had risen above 104 deg., 33 were tuberculous, and that the remaining animal was not tuberculous, but had a diseased uterus. It is further stated, that of the four cows that did not react, three were found free from tubercle, but the fourth had one small caseous gland in which tubercle bacilli were found. Here, then, we have in one case a reacting animal showing no tubercle but disease of the uterus, and in another case a non-reacting animal showing tubercle bacilli in a gland. This herd is illustrative of a certain percentage of mistakes occurring in certain ways, notwithstanding that the greatest care may be taken. And the use of tuberculin is only justifiable where it is intended to slaughter, as the separation or isolation of reacting from non-reacting animals would be a difficult matter in these colonies, and there in not much to be gained, unless tuberculined herds are completely isolated from the risk of infection. Besides this, cattle require to be free from excitement, otherwise a rise in temperature will be given in healthy cattle free from tubercle; but where cattle are stall-fed, housed, and easily handled, and under no excitement, as they are in European countries, its use is easier of accomplishment, especially where reacting animals can readily be separated from the non-reacting. The tuberculin test should, however, be useful

in diagnosing suspected cases, and animals selected for breeding, and more especially where inflammation or suspected tuberculosis of the udder occurs. About two years ago a report appeared in *The Live Stock Journal* that a quarantine of ten days is imposed on all cattle imported from Denmark into Germany, and, in addition to this, they have to be injected with tuberculin; those that react being slaughtered within five days. On the 8th March, 1897, 1,791 head of Danish cattle were tuberculined, and out of this number 678 reacted, and were declared to be suffering from tuberculosis, and were slaughtered. The carcasses of nineteen were badly affected, and were destroyed; 602 were only slightly affected, and were allowed to be sold as food; and 57 were found to be entirely free from the disease. It was found that the shorthorn cross-bred oxen and bulls reacted, whilst the old cows and young cattle did not. Among the cattle which were injected and did not react, three animals were discovered to be affected with tuberculosis, one of them being badly affected. The English Royal Commission reported that the tuberculin test was practically infallible, and this statement was made upon experiments conducted mainly by Professor McFadyean, but now it appears from more recent experiments made by that scientist, that he has modified his opinion as to the value of the test. The Professor is reported to have said: —"By using a sufficiently large quantity of tuberculin, one may cause the temperature to rise in an animal that is free from tuberculosis, and by using too small a dose of tuberculin, or of tuberculin that from some error in its manufacture is too weak, one may fail to cause an elevation of temperature, even in a tuberculous animal. And, further, that the temperature may rise from circumstances quite unconnected with the injection of tuberculin, and that the test is not to be relied on when cattle are placed under exciting conditions." Tuberculin kept too long is unreliable, if not dangerous, and should not be used.

Tuberculous Udders.

It has been satisfactorily proved by recent experiments that it is only when the udder of a cow is tuberculous that there is a risk of infection through the milk supply. In this connexion it is important that owners of cows should be compelled to give notice of inflamed or indurated udders, because nearly all forms of mammary inflammation are caused by germs of one sort or another, and, therefore, no person who has a cow with an inflamed udder should use or sell the milk, and if the udder is tuberculous or shows clinical symptoms of that disease, the cow should be destroyed. In my pamphlet published by direction of the Hon. the Minister of Agriculture two years ago on the subject of tuberculin test, I quoted the following passage, referring to

tubercular udders :—Professor Bang says that tubercle of the udder is rare. Out of 100 tuberculous cows not more than three or four at the outside have tuberculosis of the udder, whilst another observer says that of cows found tuberculous, and not specially selected, not more than one in 100 are affected in the udder. The affected part betrays itself by a slightly diffuse swelling accompanied by heat or tenderness. Usually only one quarter is attacked, and by preference a posterior quarter. Sometimes the affected organ is very considerably swollen or enlarged, and, for a long time, observations go to show that the milk remains normal, but gradually it becomes more serous and yellowish. Then it discharges small coagula which contain bacilli, and finally, but at a much later stage, the secretion becomes purulent and runs dry altogether; while the milk is undergoing the changes, the affected part of the udder is becoming more marked. Little by little its tissue becomes less supple, and the toughness increases to an almost wooden hardness, at the same time the mammary lymphatic glands are enlarged and indurated. Pathologists, who have studied inflammations of the udder, say that such are due more to different micro-organisms than to colds, whilst others say that colds are responsible for much udder inflammation, and this view seems reasonable when we consider that where cows are camped on cold damp camping places, especially in cold, damp, wet weather, inflammation is sure to result, and this condition weakens the affected part, which then becomes susceptible to germ disease. It stands to reason, then, that every attention should be given to milch cows in the way of providing shelter and comfort when the weather is cold, bleak, wet, or frosty.

The Bacillus of Tuberculosis.

The cause of tuberculosis is due to a short rod-like organism about 1-7,000th of an inch in length, discovered by Dr. Koch, in 1882. Infection is brought about in the following ways :—

1. The morbid material containing the bacillus is coughed up from a diseased lung and deposited in cow-sheds, yards, and pastures, and when dried the floating bacilli are inhaled, which produces tuberculosis of the respiratory system of man and animals susceptible to invasion.

2. The softened morbid material ejected on to the pasturage is carried into the alimentary canal of healthy grazing animals, but it does not follow that they become generally affected by the injection of tubercular matter, if there be no hereditary or constitutional predisposition to tuberculosis, or if the digestive tract is sound and free from abrasions. The bacillus is a feeble germ, readily destroyed by the action of the sun's rays, which is very destructive to bacilli of all kinds, hence the comparative freedom of our grass-fed cattle from tuberculosis.

Seats of Tubercular Disease.

Researches were made in Germany in the years 1888–9 to find out the seats of frequency in tubercular changes, and the following gives the comparative order or occurrence in different organs:—Lungs, 75 per cent. ; bronchial and other glands, 29 ; liver, 28 ; spleen, 19 ; uterus, 10 ; lumbar glands, 4 ; trachea, 3 ; udder, 1 ; intestines, 1 ; ovaries, 1. These statistics show that only 1 per cent. of tuberculosis of the udder occurs as against 75 per cent. of tubercular lungs. It is thus apparent that the respiratory organs of the cattle of Europe are most frequently the seat of tuberculosis, and this comes, naturally, from too close confinement and insanitary surroundings. In speaking of the advantages men and cattle derive from living an open-air life, Professor Law says that the ratio of disease is exemplified in the fact that cattle living an out-door life on the plains and prairies of the United States of America are but slightly affected with the disease. The ratio is one prairie steer to 60 city cows. In Europe when the country cattle are affected in a ratio of 1 to 2 per cent., those in the city dairies suffer to the extent of 6 to 20 per cent. Air rendered impure by repeated breathing is so favorable to the propagation of tuberculosis that it has been looked upon as the sole cause. Though now certain that this cannot produce tuberculosis at all in the absence of the germ, yet it is such a potent accessory cause when the bacillus is also present, that its importance cannot be too highly appreciated.

Symptoms.

The symptoms of tuberculosis vary according to the seat of the disease, and, if the lungs are affected, a weak, dull, short cough occurs in the early stages, usually dry, and seldom accompanied by expectoration. As the disease advances the ribs and flanks of the animal heave and nostrils dilate, eyes sunken, and cough more pronounced. Percussion sounds are in many cases normal, but, where tubercular changes are extensive, the sound is dull in certain spots. In fairly advanced cases, where emaciation has set in, the hair is harsh and the skin hard and fast over the ribs. Its presence is particularly noticed when the glands of the throat and underneath the ears are affected, but actinomycosis may produce similar symptoms, and naked-eye appearances do not give in all cases a correct diagnosis. Throat tubercle sometimes bursts, and the softened matter is swallowed or coughed up through the mouth and nostrils on to the pastures and other places.

Preventive Measures.

There is at present no cure for tuberculosis, and the only thing that can be done in a practical way is to isolate or tuberculin suspected animals, and destroy visibly affected ones, always taking

care that the germs of the disease are not scattered about the yards and pastures, and that the carcass and diseased organs, if badly affected, are effectually disposed of by fire, if possible, rather than burial. The stamping out process adopted in other contagious diseases was simple, because of the losses being comparatively small as compared with what would obtain in the case of tuberculosis. The method of isolating reacting animals would be difficult, as already pointed out, because the circumstances in which our cattle live and feed are totally different to those of Europe, assuming that the tuberculin test could be applied to advantage. The test to be of any advantage here must be followed up by slaughter. Cattle living in the open pasturage, and even those fed night and morning and turned out, do not take kindly to being bailed up beyond their usual time, and are, therefore, under a certain amount of restraint and excitement, and in such circumstances they are not fit to be tested. On this part of the subject it is well that I be definite, in order that it may be thoroughly understood when tuberculin should not be used. It is pointed out that it should not be used when the atmospheric temperature is too low or very high ; when the animal is suffering from inflammatory disease ; when a cow is bulling or far advanced in pregnancy ; when the temperature of the body is abnormally high from any cause ; when breathing impure air in close ill-ventilated buildings, or suffering from a scarcity of water. The experiments should be conducted when the animal is cool and fully rested, and not when in an excited state or heated by exertion.

As regards killing off visibly affected animals, it is generally conceded by stock-owners themselves that the first loss is the best, and this course is universally pursued. It is perfectly justifiable not only from the stock-owners' stand-point, but from the consumers', as it is impossible to name the time when the udder may become invaded in generalized infection, and a tuberculous beast is a menace and of no value to the owner or any one else, except for its hide. It may here also be remarked that a cow with a tuberculous lung is not dangerous, provided the disease is confined to that organ, as the disease would not be likely to extend to the udder without the animal undergoing marked changes, but in the living animal we have no means of knowing the extent or gravity of the disease. We know that tubercular disease of the udder is seldom primary, and rarely is a cow attacked in the udder first, and it is seldom that a cow with a tuberculous udder is only slightly affected in other parts. The Victorian committee of experts, fourteen years ago, sounded the warning note as regards the danger attaching to tuberculous udders when they wrote these words :—"The milk of tuberculous cows must be regarded as

infective when the udder is involved," and this is exactly what the English Royal Commission discovered lately by their own experiments.

BOVINE PLEURO-PNEUMONIA.

Until 1870 there was no law dealing with pleuro-pneumonia, which at that time had obtained a firm foothold of the herds of Australia, so much so that quarantine measures were difficult to carry out, the disease being so widely spread in all the colonies on the main land. Complaints were constantly being made both in and out of Parliament in regard to this ruinous state of things, which was most aggravated from the frequent introduction of diseased mobs of cattle coming from the northern colonies.

How Introduced and Spread.

The introduction of pleuro-pneumonia into Australia dates from 1858, a cow having been imported into Victoria by Mr. Boadle, a grazier residing a short distance from Melbourne, which, after landing, was found to be suffering from pleuro-pneumonia. Mr. Boadle's herd was destroyed subsequently, but unfortunately, the disease had spread to the adjoining herds, and travelling bullock teams (which were so numerous in those days) spread it all along the main roads and thence to the adjoining colony of N.S.W., where it became established by its rapid dissemination.

Royal Commission Appointed.

In the year 1859 a Royal Commission was appointed in this colony to devise suppressive measures, and after spending some time making inquiries and experiments, the conclusions arrived at were that the disease was neither infectious nor contagious. This unfortunate and incorrect report made matters a great deal worse, and inoculation was frequently spoken of as a preventive, if not a cure, for this disastrous and uncontrolled disease which was decimating the herds of the colonies to an alarming extent.

Treatment.

Many kinds of treatment had been resorted to, such as burning sulphur, the fumes of which were inhaled by the affected animals; kerosening their sides, &c., but none proved to be either curative or preventive, and when attention was drawn to a pamphlet by Dr. Willems, Belgium, the discoverer of inoculation, many stock-owners then began to inoculate, and since then inoculation, as a preventive measure, has been carried on with great success. The treatment of pleuro affected cattle is now a very simple matter, as there is no necessity to having recourse to wholesale slaughter of affected

herds any more than there was in dealing with scab in sheep, the stamping out of which, I may here remark, was largely effected by the lime and sulphur dip. Infected cattle only are killed, whilst suspected ones are isolated and the balance of the herd is inoculated. Inoculation, therefore, is a most important factor in getting rid of pleuro-pneumonia, and I am glad to say that it has not been found necessary to make this prophylactic measure compulsory, for the simple reason that owners invariably inoculate voluntarily when necessity arises ; and if no expert is within easy distance who thoroughly understands the operation in all its details, the inspector of the district, if communicated with, usually demonstrates it.

Inoculation Generally Practised.

It was not until about the year 1874 that inoculation became general, those owners who were previously against it, because they thought it communicated the disease to healthy animals, having changed their minds, while many others saw that they had made grave mistakes by inoculating with impure virus, not freed from blood impurities and consequent decomposition. Some of the principal stock-owners, however, knew from experience years before, how to take the virus free from blood and other forms of disease, and that it was necessary to use it fresh ; and knowledge on this subject has been extended since, so that it may now be said that inoculation is universally practised when an outbreak of the disease occurs or danger of infection exists. Inoculation experts are to be found in every cattle district who would readily give their services, if required, to the uninitiated, gratuitously or by fee. The quality of the virus is of the first importance, and, if not up to the standard, it will be much better to defer the operation until good virus can be got from a beast at the proper stage.

Obtaining the Virus.

After slaughter, the animal should be bled in the ordinary way and the carcass disturbed as little as possible, in order that the blood may not mix with the virus. The chest being opened, the virus will be found in the cells of the coagulated fibrine of the consolidated lung, and in the chest cavity between the pleura linings of the lungs and ribs, in the pockets formed from adhesions. Virus taken from either is of a clear amber colour, has no smell, and sticky to the feel. It should be used at once, and it may be added that care should be taken to strain or decant it from impurities. If, on further examination of the carcass, it is found that any other disease is present, such as tuberculosis, the virus from such a carcass should not be used but destroyed by

fire with the carcass. In hot weather good and carefully taken virus keeps for a few days, or a week, if kept in a cool place, and in cold weather it will keep much longer, and as regards preservatives, such as glycerine, salt, &c., although these may keep it fresh and free from deterioration for a few weeks longer, it is, nevertheless, found that preserved virus is not so effective as freshly obtained virus, and experienced stock-owners have a decided objection to it. When it smells badly, if used, blood poisoning is sure to set in, and the result is disastrous, especially in very warm weather. I have seen over 50 per cent. of cattle die from blood poisoning and swellings of the tail from the tip to the root, extending to the lumbar region, from carelessness and ignorance together, by using decomposed virus; and, on the other hand, where fresh virus had been used, and the operation properly performed, not one of the healthy animals has succumbed.

Fresh, Natural Virus preferable to Cultivated Virus.

On the subject of the cultivation of virus for inoculation two years ago, I officially reported on this subject as follows:—The cultivation of pleuro-virus has no advantages, as it is well known that cultivations become attenuated, and are practically worthless. The principle of collecting the virus from the œdema set up by inoculation in calves has no advantages over the system practised by us. Our practice is to collect the virus in a proper way from the chest effusion in affected animals. Here we have the toxins manufactured by the specific micro-organisms in the course of the disease. We collect the virus fresh and forthwith make the inoculations and set up a transitory, or mild form of the disease, which affords protection against a general attack. No one finds it a necessity to inoculate against pleuro-pneumonia when it is non-prevalent. When an outbreak occurs, we have the virus ready made, and every one has found this virus eminently protective. The impression abroad is that we ought always to have on hand a supply of pleuro-virus. This would entail the frequent slaughtering of calves, and the virus so obtained from such calves would not prove such a powerful remedy as the virus obtained from the chest of beasts suffering and killed of the disease. In Queensland the greatest difficulty is experienced in preserving virus, no matter from what source obtained, whether by cultivations or inoculations, and Mr. Gordon, Chief Inspector of Stock for that colony, informs me that he sometimes has difficulty in getting fresh virus to start new cultivations. It is the experience of those who have studied this subject that, to obtain reliable virus, the cultivation should not be continued beyond the second generation, and that a commencement again with a fresh case of natural

pleuro is essential. This colony is singularly free from pleuro-pneumonia, and from this stand-point alone it appears to me there would be great difficulty in getting cases of the natural disease, and I may further add that in all the circumstances in connexion with this subject, there does not seem any necessity of altering our method of obtaining virus from pleuro affected beasts, which has proved to be so successful. Inspectors of stock have already been instructed to forward samples of virus for examination and test.

Method of Operating.

Cattle to be placed in a crush or bail, and the operator to have all materials in readiness, small pellets of cotton wool about the size of a pea flattened out, saturated in the virus, and a lancet or pen-knife sharp-pointed and two edged, with a blade made fast like a lancet. The tail to be then held in the left hand, and the hair on the inside skin (within an inch of the tip) to be laid back on each side so as to leave the skin bare. An incision should then be made about three-quarters of an inch in length, and care should be taken that the cut is simply under the skin, that the bone is not touched, just barely drawing the blood and no more. The saturated pellet is then inserted, the skin closing like an envelope. If the bone of the tail is cut, inflammatory swellings set up, and, if these are not attended to in time, fatal results sometimes occur, especially in very hot weather. Stock-owners, as a rule, prefer the pellet to worsted, and, besides being the quicker method, I have found it to be the more reliable, as the whole of the virus is retained within the incised part; whilst, as regards the worsted, it is found that most of the virus is lost in drawing the thread if the opening made by the needle is not sufficiently large. The improved inoculating needle, I understand, is now being used by some stock-owners, but as to its success I cannot speak. It matters very little, however, whichever course is adopted, provided the requisite quantity of virus is lodged in the seat of the operation.

Proper Stage to Obtain Virus.

In inoculating a herd, the first thing is to get a suitable beast for slaughter at the proper stage, the symptoms of which may be described as follows:—Unnatural attitude, head and neck held low and stretched out, back arched, breathing rapid and short, short husky cough at intervals, short continuous grunt and vibration of the whole frame, eyes glassy and sunken and expressive of pain; stands as if to throw the increased weight of lungs, which weigh sometimes up to 75 lbs., backwards for ease, with elbows turned out, hind legs well under, flanks tucked up, general emaciated appearance, stands apart from the others, near to water, if possible, and in the shade; no inclination to move unless driven.

Regulations.—Quarantine.

Our regulations under *The Stock Diseases Act* 1890, provide for the prevention of the spread of disease, and quarantine is an important factor in arresting the spread of the disease. Pleuro-pneumonia is dealt with under these sections, and no stock is allowed to be removed from without the prescribed boundaries, unless upon authority of an order of the Governor in Council, or that of an inspector of stock. Inoculated cattle being immune are sooner released than they otherwise would be, whilst on the other hand there is considerable mortality in uninoculated cattle, and the quarantine is very much longer owing to the disease being allowed to run its course. As before stated, inoculation hastens the end of a diseased beast no matter how slightly affected, and thus owners get a clean bill of health much earlier than if they had not inoculated.

General Remarks.

I have had great opportunities in ascertaining the true value of inoculation, and I can safely say that, as a preventive, its power is simply magical. I cannot say that it is a curative agent, as my experience is against this theory, for, instead of curing, it acts all the other way, driving the disease out or bringing it to a climax if in the beast, and thus a herd is cleaned sooner than it would otherwise be. But it is said that it stops the disease in the early stage. Whether this statement is correct or not it will be difficult to say, but I am quite clear that it is protective if properly performed, and that in six weeks' time from the date of the last death, a clean bill of health may be given, and the inoculated herd may then be turned amongst clean stock without fear or risk. There are various stages of the disease, and in its variations all animals should at once be destroyed, infected animals isolated, and the healthy ones in contact inoculated. Those showing suspicious signs, if inoculated, may fairly be reckoned on to die quickly. They are the sickening ones showing the primary signs, and by inoculating them they are got rid of all the quicker. Moreover, all the healthy herds within a given radius should also be inoculated. Pleuro-pneumonia being but little known in the colony at the present time, I attribute this freedom in a great measure to the past dry seasons we have lately experienced; also, to the vigilance that is now exercised by our inspectors of stock on the border of N.S.W. The last instance of pleuro that came under my notice on that border was in the beginning of last year, when a travelling mob of cattle (Queenslanders) was stopped by the inspector, and permission for its introduction was refused until I was satisfied that it had been properly inoculated. To prove this it was necessary that the mob

should undergo quarantine before entering this colony, and if no deaths occurred within a period of six weeks from the date of the last death, it could then be admitted.

Within the past three or four years several mobs have been dealt with in like manner, and thus we manage to keep the disease in check. It is now over 25 years since departmental instructions were given to officers on the borders to admit mobs of cattle if they did not show more than 3 per cent. of pleuro, but now, if a mob shows any sign of the disease, it is not admitted until proved to be clean by inoculation and quarantine restrictions. It may further be remarked that a large number of cases reported to be pleuro-pneumonia are, on examination, found to be something else—pleurisy, poverty, or tuberculosis. The district inspectors are all practical men, well acquainted with diseases in stock, they having had large practical experience of the few exotic infectious diseases they are called upon to deal with. The eradication of scab, and the all but eradication of pleuro-pneumonia, mean an annual saving of nearly half-a-million sterling to this colony. There has been no wholesale slaughter of flocks and herds, owners having willingly submitted to the law as administered by this department, and now we have every reason to be proud of the position we enjoy in having, so far as pleuro and scab is concerned, clean cattle and clean sheep.

APPENDIX I.

Health Act 1890 and *Stock Diseases Act* 1890.

REGULATIONS FOR THE INTRODUCTION OF SHEEP INTO VICTORIA FROM NEW SOUTH WALES, IN WHICH COLONY THE DISEASE OF ANTHRAX IS KNOWN TO EXIST, AND FOR OTHER PURPOSES IN CONNEXION WITH SUCH DISEASE.

At the Executive Council Chamber, Melbourne, the thirtieth day of October, 1899.

PRESENT:

His Excellency the Governor;

Mr. Gavan Duffy,	Mr. Taverner,
Mr. Best,	Mr. Williamson.

WHEREAS the Governor of Victoria, by and with the advice of the Executive Council thereof, under the powers conferred upon

him by section 267 of the *Health Act* 1890 and section 4 of the *Stock Diseases Act* 1890, and of all other powers him enabling in that behalf, has deemed it necessary to regulate the introduction by land into Victoria of sheep from the colony of New South Wales, the same being a colony in which the disease of anthrax is known to exist, and has deemed it necessary to make the order and regulations following for the purpose of coping with the said disease: Now therefore be it ordained as follows (that is to say):—

1. No sheep shall be introduced into Victoria by land from the colony of New South Wales unless and until the owner or person having the charge of the same shall make and shall have lodged with the Victorian Inspector of Stock at the place where it is proposed to introduce such sheep a statutory declaration in the form or to the effect of that contained in the schedule hereto that such sheep are free from anthrax and from all other infectious or contagious disease, and that they have not within the three months next preceding the date of such declaration been in direct or indirect contact with stock infected with any such disease, and as regards the disease known as anthrax either that none of such sheep have during any part of such period been in country or travelling on routes where anthrax was present, or that such of them as have been in such country or over such routes within such time have been successfully vaccinated, and rendered immune from anthrax, in which latter case full particulars of the time, place, and person, when, where, and by whom the operation was performed shall be set out in such declaration, with a certificate thereof from an Inspector of Stock of New South Wales that he has examined the sheep referred to in the declaration, and has no reason to doubt its correctness in any particular. Provided further that no sheep which within the period of three months preceding the application for permission to introduce the same into Victoria have been in country or travelling on routes affected or suspected to be affected with anthrax shall be so introduced unless the declaration be accompanied by a certificate of a competent vaccinator that they have been successfully vaccinated for and rendered immune from anthrax.

2. Upon any stock of any kind in Victoria exhibiting symptoms of anthrax, or symptoms such as might reasonably suggest that such stock was so affected, the owner of such stock, or the occupier of the land upon which the same then is shall forthwith carry out and observe the following directions:—

(*a*) Give notice, with all practicable speed, to the nearest inspector of stock or police constable of the fact that such stock are diseased, or that such symptoms have appeared, as the case may be, stating where such stock then are.

(*b*) Forthwith isolate any diseased or suspected animals from other animals showing no symptoms of disease.

(*c*) Forthwith plug, so as to prevent the oozing of blood therefrom, the nostrils and other natural openings of the carcasses of any animals diseased or suspected so to have died, and the carcasses of any animals that may have died under suspicious circumstances, with tow, wool, hay, or other suitable material in any case saturated with a strong solution of carbolic acid or other effective disinfectant.

3. No stock, whether diseased, or suspected so to be, or not depasturing or being on land upon which any stock suffering from anthrax, or suspected so to be, have been, or on land worked in conjunction therewith, shall be removed or permitted to escape therefrom ; and no stock from outside shall be permitted to come upon any such land, in either case, until such land has been declared clean by an inspector of stock, without the written authority of an inspector of stock first had and obtained.

4. No occupier of land upon which any stock suffering, or suspected to be suffering, from anthrax are, or have been, shall, until such land has been declared clean by an inspector of stock, remove, or permit to be removed therefrom, without the written authority of an inspector of stock first had and obtained, the carcass of any diseased or suspected animal, or any dung from any animal affected with anthrax, or suspected so to be, or any dung, litter, fodder, or other material with which any such animal or its carcass may have come in contact, or being in or about any place in which any such animal has been kept.

5. When any animal has died, or is suspected to have died, suffering from anthrax, no person, not being an inspector of stock, shall cut or otherwise interfere with the skin of such animal so as to permit of the escape of fluids, except for the purpose of microscopical examination or other test, and then only with the authority of an inspector of stock, who shall forthwith report the circumstances to the chief inspector of stock.

6. Every occupier of land upon which any animal affected, or suspected of being affected, with anthrax is or has been shall forthwith, after any symptoms of anthrax have appeared, and from time to time, if considered necessary by an inspector of stock, until all risk of the disease spreading is at an end, and to the satisfaction of an inspector of stock, thoroughly disinfect, or cause to be disinfected, all places, buildings, fixtures, fittings, dung, litter, fodder, and other material used for or being about any diseased animal, or animal suspected of so being, or with which any such animal may have come in contact, with freshly burnt lime or other

approved disinfectant. Provided that in the event of its being made to appear to an inspector of stock that any place or thing is incapable of being disinfected, or that it would be unreasonable to insist on the requirements of this regulation being observed in any particular instance, he may sanction the place or thing being treated in such other manner, for the purpose of preventing contagion or infection, as he may think reasonably sufficient under the circumstances.

7. No inspector of stock shall declare any land or place to be clean until a reasonable time has expired from the last appearance of any symptoms of anthrax in any animal, nor until the occupier thereof has complied with the requirements of these regulations as to disinfecting or treating such land or place to prevent contagion or infection as hereinbefore provided.

8. No inspector of stock shall permit the removal from off any land or place of the carcass of any animal which has, or is suspected to have, died infected with anthrax, or of any dung, litter, fodder, or other material that has been in contact with or used about any animal having or suspected to have had anthrax, until the same has been thoroughly disinfected with fresh burnt lime or other sufficient disinfectant.

9. No inspector of stock shall, except for the purpose of immediate slaughter, permit to be removed from off any land or from off any land worked in connexion with any land upon which any case or suspected case of anthrax has occurred, any stock that has not been vaccinated and rendered immune from anthrax, and in respect to which a certificate of such vaccination by a competent vaccinator has not been lodged with him, unless the occupier of such land or the owner of such stock has kept the same for a period of not less than seven days immediately preceeding the date of their removal in some part of the land isolated from any place where any diseased animal or animal suspected so to be is or has been kept, or over which any such animal has or may have passed.

10. Such of the regulations for the time being in force under the *Stock Diseases Act* 1890 as are not inconsistent herewith shall be read and construed as incorporated in these regulations.

Declaration by Owner, and Certificate of Health by Inspector.

I [*name and full address*], do solemnly and sincerely declare that the undermentioned stock are, to the best of my knowledge and belief, free from anthrax and all other infectious and contagious diseases in stock; that such stock have not, within the

next preceding six months, been in direct or indirect contact with stock infected with any such diseases, including anthrax, (*a*) *nor, as regards anthrax, has such stock during that period been on runs or routes known to be infected, nor to have travelled over routes known to be so affected with that disease.**

(*a*) The words in italics may be omitted in the case of sheep being vaccinated, and in which case the owner to state place, date, and by whom the vaccination was performed, and that the certificate produced is the certificate of the person performing the operation.

Particulars of Stock.

No.	Description.	Sex.	Brands and Marks.	Name of Owner and Person in Charge.	Route and Destination.	Consignee.

And I make this solemn declaration conscientiously believing the same to be true, and in virtue of the provisions of an Act made and passed in the ninth year of the reign of Her present Majesty, intituled "An Act for the more effectual abolition of Oaths and Affirmations taken and made in various Departments of the Government of New South Wales, and to substitute Declarations in lieu thereof, and for the suppression of voluntary and extra-judicial Oaths and Affidavits."

(Or, if made in Victoria.)

And I make this solemn declaration conscientiously believing the same to be true, and by virtue of the provisions of an Act of the Parliament of Victoria rendering persons making a false declaration punishable for wilful and corrupt perjury.

(Signed)

Made and signed before me at this
day of 189

Note.—In case of Victoria, declaration may be made before a Commissioner for taking Oaths, &c.

Signature of Magistrate—

J.P.

I have examined the stock referred to in the above declaration, and have no reason to doubt its correctness in any particular.

Inspector of Stock.

Date—
Address—

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* If stock herein referred to have been vaccinated, the owner should declare to that fact by adding the following particulars after the word "*disease*":—And I further declare that the undermentioned stock were vaccinated and rendered immune on or about the day of , at by , whose certificate is herewith produced.

And the Honorable John William Taverner, Her Majesty's Commissioner of Public Works for Victoria, shall give the necessary directions herein accordingly.

THOS. BRISBANE,
Acting Clerk of the Executive Council.

APPENDIX J.

HORSE BREEDING.

(*By G. Pentland, Chief Inspector of Stock.*)

Good serviceable horses of all classes have greatly increased in price within the last few years, and there is now a wide field for the expansion of the horse-breeding industry, not only in the heavy-weight hack and carriage class, but in heavy draughts for farm and city work. Only a few years ago the latter class of horses did not pay to breed, but now that prices of all classes of horses have risen so greatly, nothing can be more profitable than breeding good horses of the right stamp. At that time a good draught horse could be got for £15 to £20, four and five year olds, but now for the same class of horse £30 and upwards is readily obtained. It then appears that more attention is required to be given to an industry that has been neglected of late years from several causes, due, for the most part, to carelessness, or the want of a thorough knowledge of the principles of breeding; for, if breeding horses is desirable, it is surely worth while to breed to the very best advantage, from

the best of stock, and under circumstances that will command success. There can be no possible good in breeding inferior horses, as stock of this kind is a heavy tax on the breeder, who cannot dispose of useless sorts in the same way that he could with inferior breeds of cattle or sheep. Prices for useful horses are now so good, and advancing, that I consider the time has come, for small land-owners especially, either to breed horses that will pay, whether for local use or export, or not to breed at all. Over a quarter of a century ago we had superior draught horses bringing from £40 to £60, but of late years prices fell to such an extent that it did not pay farmers to continue breeding. Now that there is a good demand for horses of all classes, the matter of giving more attention to breeding is worthy of serious consideration, and it may be added that what is wanted is better quality in preference to quantity. Breeders require to observe the principles of breeding and feeding, otherwise there can be nothing but unprofitable results.

Inferior Stallions.

No country is better adapted for horse breeding than Australia, and Victoria, heretofore, has held the premier position in the export trade. The highest authorities of India and elsewhere, who personally know the high qualities of the Australian horse, praise him most favorably, and those who have had no experience are not in a position to assess his true value. Horses do not deteriorate in an eminently suitable climate without a cause, and no cause, that I am aware of, is so detrimental to the production of prime Australian horses as the use of inferior or unsound stallions. Cheap inferior stallions are an evil, and their use should be discouraged ; they should be got rid of by some means ; and, as a preventive, I would recommend the imposition of a registration fee and a wider distribution of superior horses. The mob of inferior horses continually bred, year after year, afford ample evidence of room for improvement.

That this inferiority is due greatly to the small breeder, in many cases, being unable to pay for the service of a first-class sire cannot be gainsaid ; but breeders should, by every means in their power, endeavour to avail themselves of the very best sires obtainable, particularly if they have good mares ; and it should always be borne in mind that it does not pay to breed horses from anything but good and well-mated sorts.

Improvement in Breeding Highly Desirable.

Many of our farmers and breeders are not slow in availing themselves of the valuable information conveyed to them through the public press and in other ways, and every encouragement

should also be given by agricultural societies in bringing about a better state of things than at present obtains. In offering remarks on this important subject, it is proper to add that advice and assistance cannot be too freely given, as it is quite clear that the established laws of breeding, for some years back, have had but slight consideration, whilst the deterioration of our overstocked pastures is an equally responsible factor. What is wanted more particularly is greater weight combined with quality, and to avoid sending into the markets three-year-old stock undeveloped. An infusion of new blood would, in some instances, be also an improvement where certain qualities are an object in breeding useful horses, and, indeed, the selection and introduction of the best stock that can be found in any colony or country is most desirable in aiming at excellence should this be seen to be necessary. When the country was lighter stocked we had a much larger proportion of useful horses, weight carriers in particular, that would do long distances in a remarkably short space of time, or travel daily for weeks and months at a stretch, living only on the natural grasses and herbage, and be none the worse, even with the comparatively scanty food they got at short intervals of rest, whilst performing arduous work. This fact shows that horses reared in a natural way had great stamina, and that the Australian climate, with its moderate rainfall, in most respects not unlike that of Arabia and Persia—which are remarkable for producing horses of the highest qualities for speed and endurance—is all that can be desired in the production of horses of splendid conformation and great in action. The present time is decidedly opportune for small land-owners to make the most of the situation, and start upon the lines laid down by the best authorities on the laws of breeding, and shoot down all inferior or worthless animals not worth their grass.

Influence of the Dam.

It is an axiom in breeding that "like begets like," and to produce good horses we not only require suitable country, good sires and dams, but good management as well to insure success ; for, in aiming at excellence, we must strive to acquire the true art of the breeder, namely, judicious selection of animals intended to effect certain results. On this principle, our famous studs of sheep and cattle have been founded, and on no other principle shall we be able to produce good useful horses. If breeders aim at this, success is inevitable. To keep up the reputation of colonial horses it is also essential to retain a good class of brood mares, and not part with our breeding capital, as is frequently being done in the export trade. The export trade is a potent factor in this direction ; therefore we should retain and breed mares capable of producing

good results in catering for foreign markets. The remarks of that most excellent and accepted authority, Youatt, written years ago, are true and incontrovertible—"Peculiarity of form and constitution," he says, "are inherited from both parents; that excellence of the mare is a point of quite as much importance as that of the horse, and that out of a sorry mare, let the horse be as perfect as he may be, a good foal will rarely be produced." This advice ought to sink deeply into the hearts of careless breeders. Experience goes to show that in selecting mares for breeding cavalry horses, the mares should be good in the saddle, and possess those other qualities sought for as much as possible.

Thoroughbreds and Clydesdales.

Cross-breeding.

These colonies are possessed of a high standard of the requisite materials for breeding most useful horses, namely, the thoroughbred and the Clydesdale, and from these two breeds great horses are produced by judicious crossing. The best remounts and carriage horses are obtained from this course of breeding and selection—from the cross between a good stout thoroughbred sire and a half-bred or three-quarter bred mare. This course is largely unavoidable, as we have no special or established breed of horses for breeding remounts or weight carriers; but careful breeders do well on the principle of selection, selecting the best of the females that prove on trial good in the qualities they desire, and parting with those unsuitable. In cross breeding nothing definite is got beyond the first cross, as a rule, and successful breeders are well aware of this.

The Arab.

The qualities of the Arab are of a high order, but unfortunately, he is not much in favour on account of his undersize. He, nevertheless, stands well for density of bone, purity of race, and freedom from those defects usually associated with great domestication. In his native home he has that freedom of life that the Australian horse has, and which horses bred and housed in the cold climates of European countries do not enjoy. An infusion of Arab blood might be desirable where special qualities are aimed at.

English Coaching or Roadster Breeds.

Concerning the coaching or roadster breeds that have been tried in these colonies, it is important that observations be here noted. Mr. Mackenzie, District Inspector of Stock for North Gippsland, an experienced horseman, informs me that a good many Cleveland-bred sires that he has seen show defects in one way or another,

either in the bone being round, or joints knotty. A horse of this kind, it need hardly be pointed out, should be avoided, as the stock are always liable to splints, curb, sidebone, ringbone, and other such ailments. Clevelands and trotters have been tried in that district, but they have not proved too successful ; and, on the whole, his opinion is that there is nothing like a blood horse with carefully selected mares to breed carriage horses, remounts, and roadsters. On the subject of these defects we have an excellent authority, Colonel F. Duck, who states that there is no country in the world better adapted than Australia for breeding horses ; that if proper attention were paid to breeding from sound stallions only we should soon hear the last of our horses being affected with ringbone, &c., or troubled with roaring. I think it well, also, to bring under notice some remarks made not long ago by Mr. Rouse, an extensive horse breeder in New South Wales, in speaking on the subject of raising a desirable class of mare. His advice is that—"If farmers bred from the Yorkshire coach horse they would raise a class of mare fit for all agricultural purposes, and these mares mated with a high-class blood horse would produce stock fit for useful purposes." This suggestion, coming from an experienced authority in breeding, should have some weight, and must receive due consideration. Every effort should be made in the direction of finding out the most suitable class of horse to produce good brood mares for remount purposes. Horses that have been used within themselves for generations as roadsters have something to recommend them, as they have the inherent elements for doing the class of work that is specially required of them ; as, for instance, if we required a racer, we should certainly breed from nothing else but the best of racing power on both sides. The Yorkshire coach horse is equal in bone and power to the heavy cavalry horse of 16 hands.

It is the opinion of other equally competent authorities that the Yorkshire and Norfolk breeds are destined to play an important part in the production of horses fit for artillery and transport purposes. On this part of the subject it may be also stated that it is found in the Gippsland district that the most suitable class of horse for producing what is termed "gunners" is an active draught sire, possessing a good head and neck, mated with light mares, whilst mares from this cross would do to cross with the blood horse. The Suffolk Punch light mares are also found to be eminently adapted for the breeding of useful remounts and gunners. The English hackney stallion is, moreover, found to mate successfully with our thoroughbred mares, and to produce stock fit for export. On the whole, I am of opinion that the thoroughbred blood horse as a sire cannot be surpassed in breeding useful carriage horses and remounts, and that, although

other kinds of sires can be used to good advantage, breeders with suitable mares will do well to weigh this matter well in their minds.

Victoria Eminently Suitable for Horse Breeding.

It is well known that Gippsland has contributed the largest share of horses for the Indian trade of any part of this colony, and it is from this quarter that the bulk of our exports will continue, although many other parts are equally suitable, notably the North-Eastern, Mitta Mitta, Goulburn Valley, and Upper Murray districts, where large numbers of splendid horses, second to none in the world, are bred. The western district was at one time celebrated for the breeding of good useful horses, but now that country is so valuable for other purposes that breeding in a large way is out of the question. Where the limestone formations abound in hilly country we have horses with good feet, bone, and muscle, and limestone formations very largely exist in these districts. Country not much required for agricultural purposes, but eminently adapted for horse breeding, is also to be found in that portion of the Snowy River Valley, comprising the parishes of Tubbut, Deddick, Suggan Buggan, and similar country, not fenced in and not overstocked. In the Buchan, Orbost, Omeo, and Mitchell districts, large numbers of Indian remounts have been bred profitably, but of late years this trade has gone back, owing to the fact that many farmers have parted with their best breeding stock, leaving themselves the inferior sorts or rubbish. The country to be avoided is soft, marshy lands, with too great rainfall and with no limestone or salt, where flat feet are developed. Our statistics of exports to India show that our trade with that country is a good one, and that this colony, of all the colonies, is eminently suitable for the production of horses of the highest standard for military purposes.

This fact shows that it will be the fault of our breeders if they do not keep up the reputation of the horse industry of the past. The great endurance of our horses cannot be better exemplified than by a reference to the performances of former days, and the distances covered in a day under all conditions of weather. It was only a comparatively few years ago, before our railway system attained its present dimensions, that journeys had to be made to Melbourne from long distances in a limited time, and it was no uncommon thing for horses, combining strength and breeding, to carry heavy weights 70 miles and upwards a day. Instances are given where 100 miles on an emergency have been done in fifteen hours, and it is acknowledged by those having experience of the qualities of both English and Australian horses that there is no comparison between the two for capability for

work. As regards the hardihood of our horses, in his book on the Australian saddle horse, the late Mr. Curr, Chief Inspector of Stock, says—"If an English horse in England, for instance, of a certain figure and breeding, was found, on trial, to perform, say 30 miles a day for a fortnight with stable feed as the maximum of his capabilities, then an Australian horse of exactly the same figure and breeding, with no other food than grass, would certainly perform 45 miles a day for the same period." Under natural and favorable conditions there can be but one opinion that the chief characteristics of the Australian horse are soundness of constitution and general freedom from defects, unless where defects are inherited from bad parentage. Horses in the older world have not the natural hygienic advantages those here possess, they are housed for a considerable part of the year, and, besides this, it costs more to breed them.

Extension of an Export Trade.

On the subject of the prospect of an export trade being capable of extension, Major-General Hutton, a little time back, expressed his opinion that an extensive lucrative trade could be developed with the European Powers by supplying them with horses for military purposes, our superior climate and soil being all that could be desired. He pointed out that we could command the trade over the heads of all other countries, and that it was worth two and a half millions sterling annually. It would take some time, however, for Australia to attempt such an extensive trade as this; but if we got a fair share to commence with, we might be well satisfied. There is no doubt that there is a large field for breeding horses in many parts of Australia where the climatic conditions are so suitable. It does not, however, pay to breed horses in large areas, as has been proved, and this industry at present is one more for the small land-owner or farmer, where horses can be handled and managed in a skilful way in small lots. Principally between Germany, France, and Great Britain 30,000 horses are required every year, and the price paid for a five-year-old light cavalry horse is about £40, for life guards £60, and for carriage horses £100 to £700, hunters from £100 to £500. German dealers give from £60 to £100 for the best mares to be found. None but really good horses will command these prices, *and it will be unfortunate if we attempt to send anything but the best of stock in the initiation of an export trade to these countries.* It is to be hoped, when the time comes to act in this matter, that we shall be equal to the occasion, and that it will be met by more attention being given to the better selection of both sires and dams. At present all our best horses can be exported with advantage to the Indian markets, so that to extend our breeding

industry or to improve our horse stock generally, we certainly require to breed to higher standards. One firm of exporters has informed me that if they could get a sufficient number of horses within a reasonable time they would undertake to find markets at payable rates. It stands to reason that if exporters can get suitable horses in Victoria they would very much prefer getting them near to the principal shipping ports, and this would enable buyers to pay better prices where extra expenses can be saved. The average prices given by the Indian Government is about £45. By judicious arrangements for freight at low rates, these prices should leave a fair profit to the breeder, and pay better than anything I know. At any rate, I bring the matter forward in the hope that our breeders and exporters may be stimulated to further exertion and enterprise.

The classes required for military purposes are of the following descriptions :—

Medium cavalry horse	...	15·1 to 15·2½	hands.
Chargers ...	...	15·1 to 16	„
Wheelers ...	...	15·1½ to 15·3	„
Centres ...	...	15·2 to 16	„
Leaders ...	...	15·2½ to 16	„

Native cavalry (better known as Bengal Bounders) at reduced heights.

The transport horse of bone and power, 15·2 hands.

We have plenty of good sires and dams in this colony to produce horses of the qualities indicated, and there should be no difficulty whatever in maintaining our reputation, and being ready to meet the requirements of other countries. No other country can compete with Australia in her ability to produce horses of all classes of the very highest standard ; and we have, therefore, only to watch what is going on in the production of horses elsewhere for the supply of the military powers mentioned.

The latest returns of horses exported from this colony are for the year 1897, and are as follow :—To West Australia, 172 ; Bengal, 2,295 ; Bombay, 200 ; Madras, 100 ; Mauritius, 140 ; Straits Settlements, 440 ; total, 3,347. On an average 3,000 head of horses were exported to West Australia during the years 1894, 1895, and 1896, but that trade has now nearly ceased, since the extension of the railways to the gold-fields. During the last six years the average number shipped to India, Mauritius, and the Straits Settlements was about 4,000 in round numbers ; and for all Australia last year about 7,000.

This export trade has been going on for many years, and can readily be increased if breeders generally raise the quality of their stock. The time has now come for decided action in the matter of raising the value of our horse export trade, which can easily enough be done. When we can send home such horses as

"Carbine" and "Carnage," bringing 13,000 and 10,000 guineas respectively, we should have no fear of success, and it appears to me that the time is near at hand when the military powers of the world will only be too glad to get our valuable horses at such rates as will pay them to become our customers and pay the breeder. Breeders will do well to utilize the blood horse of good bone and substance.

In conclusion, I may add that our horses are fortunately free from all infectious and contagious diseases, and that every precaution is taken to keep foreign diseases out of this colony. Queensland stock is not allowed to be introduced by sea, whilst stock by land is subjected to inspection by the New South Wales inspectors; and our regulations require, in addition to this, that stock undergo a quarantine of three months in that colony before examination by the Victorian inspector on the border. These precautions are admitted to be quite protective against the introduction of Queensland ticks, &c. I should not have referred to this matter but for a rumour that the Indian authorities are afraid of the tick pest which is in Queensland, and when they find how strict our regulations are, and how favorable our position is, they cannot come to any other conclusion than that it would be manifestly unfair to place an embargo or restrictions of any kind on the exportation of our horses.

APPENDIX K.

Stock Diseases Act 1890 (No. 1141).

INTRODUCTION OF POULTRY INTO VICTORIA.—REGULATIONS.

At the Executive Council Chamber, Melbourne, the fifteenth day of August, 1898.

PRESENT:

His Excellency the Administrator of the Government;

Sir George Turner,	Mr. Foster,
Mr. Peacock,	Mr. Williamson.

WHEREAS by Part I. of the *Stock Diseases Act* 1890 (No. 1141), it is among other things provided that the Governor, with the advice of the Executive Council, may from time to time make such Regulations under the said Part of the said Act as may be deemed expedient for, among other purposes, regulating and fixing the conditions upon which certain kinds of stock may be introduced into Victoria, and for the inspection of newly-introduced stock, and for regulating the introduction into Victoria of any fittings, and for the seizure, sale, or destruction of any such

fittings landed without the written authority of an Inspector of Stock : And whereas it has been deemed expedient to make the Regulations following, fixing the conditions upon which certain kinds of stock, namely, Poultry, may be introduced into Victoria, and for the inspection of such newly-introduced stock, and for regulating the introduction of fittings, and for the seizure, sale, or destruction of any such fittings landed without the written authority of an Inspector of Stock : Now therefore His Excellency the Administrator of the Government of Victoria, by and with the advice of the Executive Council thereof, in exercise of the powers conferred by the hereinbefore recited Act, and of all other powers him enabling in that behalf, doth hereby make the Regulations following (that is to say) :—

1. These Regulations shall come into force on the 1st day of September, 1898.

2. In the construction of these Regulations, unless the context otherwise requires it, the following words shall include the meanings respectively assigned to them (that is to say) :—

"Fittings" shall include any cage, pen, box, hamper, basket, or other receptacle at any time theretofore used for carrying or confining poultry.

"Inspector shall include the Chief Inspector and any Inspector of Stock under the *Stock Diseases Act* 1890.

"Owner" shall include any carrier, forwarding or other agent, servant, or other person having for the time being the care, custody, or control of any poultry.

"Poultry" shall include any kind of living land or water bird ordinarily bred or reared in a domestic state.

3. No owner shall bring, introduce, or permit to come into Victoria any poultry or fittings, either by land or sea, except in accordance with the conditions prescribed by these Regulations.

4. No owner of poultry or fittings suffering from or infested with poultry ticks (otherwise argads, hereinafter referred to as "ticks"), or of poultry or fittings which have within six calendar months from the date of their proposed introduction suffered from or been infested with ticks, or which have been in contact with animals or birds suffering from or in contact with fittings or in places infested with ticks, shall bring, introduce, or permit the same to come into Victoria.

5. No owner shall bring or introduce any poultry or fittings into Victoria except at some port or place from time to time appointed by the Governor in Council for that purpose, or, in default of such appointment, at some port or place for the time being appointed by the Governor in Council for the bringing or crossing into Victoria of other kinds of stock.

6. Any owner of poultry or fittings, the introduction of which is not prohibited, desiring to bring or introduce such poultry or fittings into Victoria shall give not less than 48 hours' notice, in writing, of such his desire to the Inspector of Stock for the appointed port or place at which he desires such poultry to be brought in or introduced, giving particulars of the person whose property they are, of the place whence the poultry or fittings are being brought, and the route followed and mode of transport, and, in the case of poultry, of the kind or kinds, number or numbers, and sex of all poultry proposed to be introduced, and in the case of fittings, of the kind and number. Every such notice may be in the form or to the effect of that contained in the first schedule hereto.

7. At or before the inspection by an inspector in accordance with any such notice, the owner shall furnish to such inspector a statutory declaration declaring that none of the poultry or fittings the subject of such notice are suffering from or infested with ticks, and that such poultry and fittings have not, within six calendar months from the date of such notice, suffered from or been infested with ticks, nor been in contact with animals or birds suffering from nor in contact with fittings nor in places infested with ticks. Every such declaration may be in the form or to the effect of that contained in the second schedule hereto.

8. At the time appointed for inspection in accordance with any notice as aforesaid, the owner shall produce, at a place to be appointed by the inspector, all poultry and fittings referred to therein to the inspector, and aid him (providing such assistants as the inspector may require) in fully and closely inspecting such poultry and fittings, giving such inspector every assistance in carrying out his duty.

9. After such inspection as aforesaid the owner shall, if so required by the inspector, disinfect all such poultry or fittings in or with some disinfectant to be approved by the inspector in his presence and to his satisfaction.

10. If the inspector is satisfied that the provisions of these Regulations have been complied with, and that such poultry or fittings are free from ticks, such inspector may give to the owner a permit authorizing the introduction of such poultry or fittings into Victoria at the place named therein ; such permit may be in the form or to the effect of that contained in the third schedule hereto.

11. All fittings brought or introduced into Victoria in contravention of these Regulations may be seized by any inspector wherever found and forthwith destroyed.

Stock Diseases Act 1890 (No. 1141).

REGULATIONS (POULTRY).

First Schedule.

Notice by owner of desire to introduce Poultry, &c.

To the Inspector of Stock,

Please take notice that I desire to introduce into Victoria the poultry and fittings the property of
of detailed below at
on next the day of 189
and I shall be ready for you to inspect them at any time after the hour of in the noon.

The place whence the above are being brought is

Kind or Description.	Sex.	Number.

Dated this day of 189

(Signature)

(Address)

Stock Diseases Act 1890 (No. 1141).

REGULATIONS (POULTRY).

Second Schedule.

Declaration by person introducing stock as to freedom from Tick, &c.

I of do solemnly and sincerely declare that the whole of the poultry and fittings described below the subject of the notice given by me to the Inspector of Stock at on or about the day of 189 are free from poultry ticks or argads, and that none of the poultry and fittings referred to have, within six calendar months from the date of the service of such notice on the inspector, suffered from or been infested with poultry ticks or argads, nor

have they been in contact with animals or birds suffering from or in contact with fittings so infested, nor have they been in places so infested; and I further declare that the particulars below are true and correct in every particular.

Particulars.

No.	Description.	Sex, &c.	Name and Address of Person whose Property Poultry and Fittings are.	Where from and Route.	Consignees.

And I make this solemn declaration conscientiously believing the same to be true, and by virtue of the provisions of an Act of the Parliament of Victoria rendering persons making a false declaration punishable for wilful and corrupt perjury.

Declared at in the colony of Victoria this day (Signature of declarant). of 189 before me a Commissioner of the Supreme Court of the Colony of Victoria for Taking Affidavits, or a Commissioner for Taking Declarations and Affidavits, or a Justice of the Peace in and for the Bailiwick of Victoria.

Stock Diseases Act 1890 (No. 1141).

Regulations (Poultry).

Third Schedule.

Permit for introduction of Poultry and Fittings.

Permission is hereby granted to of to introduce at in Victoria from the poultry and fittings described below the poultry of of and consigned to of which poultry and fittings I have this day inspected and found free from tick.

Description.

Number.	Kind or Description.	Sex of Poultry.

Dated at this day of 189

Inspector of Stock
at

And the Honorable John William Taverner, Her Majesty's Minister of Agriculture for Victoria, shall give the necessary directions herein accordingly.

THOS BRISBANE,
Acting Clerk of the Executive Council.

APPENDIX L.

DISEASES IN STOCK.

By G. Pentland, Chief Inspector of Stock.

(Read before the Shepparton Agricultural Society.)

This subject is so comprehensive in all its bearings that, notwithstanding what I may have already said and written elsewhere, there is so much yet to be brought under notice that I think I cannot do better at the outset than touch somewhat lightly upon those complaints arising from climatic conditions, those ailments amongst cattle so prevalent in seasons of scarcity. In looking over historical records I find that in all parts of the world certain complaints arise from food of inferior quality and likewise inferior water, and these colonies are no exception, especially in times of drought. Going back to ancient history, we find that maladies in cattle existed from the earliest periods, due in the main to climatic influences, or certain conditions of climate and soil which produced disorders of one sort or other. In Egypt, the overflowing of the Nile periodically and the rank vegetation which these inundations brought about, followed by severe droughts, produced all kinds of evils. In Rome the overflowing of the Tiber in

certain seasons, until the low-lying lands were drained, caused great mortality in man and beast, and in these ancient times murrains in cattle caused contagious disease in the people. Bad drainage was then a fruitful source of disease, no matter whether in cities, hamlets, or private holdings, and these facts show how careful we should be in all our sanitary arrangements if we wish to maintain a healthful state of things. The ancient Romans saw the necessity of draining their lands and places, keeping everything down that tended to produce diseases. They had wars in all their horrors, and contagious disease, arising from putrefying dead bodies, which spread to man and beast rapidly. This fact shows how necessary it is that the carcasses of animals should be burned or buried, no matter from what cause deaths occur. We have more mortality than we should have; preventable causes being within the reach of every one, as I shall endeavour to show further on. It is true that we have had hard times in some parts from the past dry seasons, but now our outlook is very encouraging. When I bring under your notice the historical fact that 400,000 people perished in the floods which followed parching droughts, accompanied by famine, in the country watered by the Rivers Kiang and Hoangho, through the great physical changes and disturbances from earthquakes which China underwent in the years 1347–8–9, it is easy to understand how the peoples of this earth are simply the creatures of circumstance, and that our fates depend upon a higher power than our own. We nevertheless can do a great deal to help ourselves in the way of mitigating evil effects from unforeseen adversity, and accidental causes may at times come to our rescue, but not often. It was by accident that agriculture came to the rescue of Lorraine, the marshy lands having been drained and the air relieved of its humidity and putrid vapours, which in certain seasons had been so fatal to man and beast for several successive centuries. Nature has done a great deal for Australia, the powerful agency of the sun's rays being a wonderful factor in the suppression of disease, but, I think, a great deal requires to be done in country destitute of timber, by planting suitable trees and hedges to give shade to our stock from the great summer heat. Our eucalyptus or gum trees have been found to be beneficial from a sanitary point of view in certain portions of Italy, and we cannot do better than let the eucalyptus alone where it is wanted, and plant such and other suitable trees, &c., where required; not only for shade, but to assist in the purification of insanitary surroundings. In the year 1664 a comet was observed, and soon afterwards the great plague of London, which was so disastrous to human life, developed itself, and, instinctively, birds and wild beasts left their haunts, whilst insects of all kinds, and frogs in immense masses and

swarms, appeared at the same time. Does not this circumstance show that climatic and physical changes, whilst uncongenial to some classes of animals, are congenial to others, and illustrate the natural laws for producing changes in the animal economy of man and beast? In these modern times we have the science of bacteriology telling us the specific nature of any disease produced from bacterial agency, and this is a great help in determining whether infection or contagion is the cause of mortality or not. In this connexion I may state that I have noticed in my experiences, where the pastures and waters are in country deficient in salt or lime, there is a great tendency to the disturbance of the animal economy; that the bone of animals bred or running on such lands is not so dense as in country containing these essentials.

Concerning the value of salt, experiments made a good many years ago on prisoners in a foreign country, by withholding salt from their food, showed that their bodies became infested with worms and parasitic life, a medium of further torture. Cattle in country devoid of saline matter eat harness leather for the sake of the salt, and goats lick the salty sweat from horses' legs, and in back country where wild indigenous animals run, particularly kangaroos, they are generally infested with worms, and from such facts we learn the value of salt, or of country containing saline matter, in keeping down parasitic life, notably the fluke worms; and the lung and stomach worms. This common but valuable article exercises more influence in hygiene than most people are aware of. The flesh of phthisical people or people who don't care for salt becomes pale, soft, and watery, and therefore the influence which the want of salt may have in the production of bacterial diseases in our stock is a question which deserves the greatest attention in these times, and the absence in soils of essential chemical properties is undoubtedly the cause of great loss to owners of stock of all kinds. Heat and moisture produce all sorts of pests and troubles, and in some years we have immense swarms of grasshoppers and caterpillars clearing everything before them, not leaving a blade of grass behind; then we have fluke and water-rot in country deficient in saline matter, particularly if we have rains in January, while the ground is warm. The past dry seasons have been beneficial in reducing pleuro-pneumonia, tuberculosis, fluke, &c.; but in country where the drought has been severest we have had, unfortunately, actinomycosis, cripples, impaction, paralysis, &c., and these troubles come and go according to season, and the extent of prevalence varies according to the condition of the food and water supply. The conditions of climate and soil are largely responsible for many preventable ailments of stock, but irrespective of this, good or

bad management, under circumstances favorable or unfavorable, makes all the difference in results. Under good management in comparatively indifferent country success is attained, whilst the want of judgment and skill brings about disaster in various ways. In the breeding and rearing of stock there is always something to learn as well as the prevention of all those ailments to which they are so liable and so susceptible. The neglect of one man in the matter of contagious diseases may be the ruin not only of himself but of many others; hence the necessity of laws and of their administration in a just and equitable manner.

The disease, however, which seems to concern all parts of the world at the present time is

Tuberculosis.

And I now here offer some remarks on it which may be of some use, since we are all concerned in seeing it dealt with in the most summary manner. In this matter we have to combat an invisible foe to a very large extent, and we have no really practical method of doing so. We know how to deal with the enemy when we meet him, but we naturally feel that we are at a great disadvantage when we have no external evidence of his existence, no outward and visible signs. We certainly destroy animals showing symptoms, and as a rule owners are only too willing to get rid of animals affected as quickly as possible, but to get rid of the disease in a wholesale way, the question of cost is a grave one; and it is chiefly on this ground that England is not doing as much as she might do with all her advantages as regards easy and ready handling of cattle. It has been estimated that to get rid of this disease in the dairy herds of England on the principle of compensation, it would take nineteen millions sterling to accomplish this, *i.e.*, $3\frac{1}{4}$ millions of cows would have to be taken from the milking sheds, and, if this were done, the milk trade would be done away with for a time. The enormous expenditure required in such an undertaking is a matter which is likely to stand in the way of immediate action being taken on the basis of slaughtering all animals reacting to the tuberculin test. In this connexion I may state that Victoria did a wise thing in placing tuberculosis on the schedule of contagious diseases long before the discovery of the tuberculin test, and we ridded ourselves of many dangerous animals showing visible signs that would have been allowed to live for a considerable time, scattering the germs of the disease in all directions. England at present, unfortunately, does not insist on the destruction of visibly affected animals, or animals that on physical examination are found to be tubercular. Besides slaughter, there is another measure that

should always be taken by owners to safeguard the health of unaffected animals, namely, isolation of all suspected animals. No stock-owner should be without an hospital paddock or small enclosure so as to have complete isolation from the rest of his herd, and if he finds the animal is getting worse, especially in the case of suspected tuberculosis or other infectious disease, he should have it destroyed at once, using all sanitary precautions for the safety of the other stock. Clean surroundings are also a great factor in the management of a dairy herd ; clean cattle, everything clean and sweet, should be the motto of the model dairy farmer, and above all things the milk of a cow with a tuberculous udder, or an udder showing suspicious signs of tuberculosis, should not be used, for it is in this organ that danger lies. Samples of such milk should be examined microscopically if a doubt exists. Radical measures to be undertaken with the view of exterminating tuberculosis from our herds will require to be of an intercolonial character, and in this matter there can be no finality even under the greatest success, whilst the human family is afflicted, and this means till the end of time. In these colonies the question of compensation is a minor one compared with the getting rid of disease or of suspicious animals; hence we have a great factor in the suppression of disease by the owners themselves, who do not wait for departmental action or for considerations of any kind once they are satisfied that disease exists. The great cause of the spread of tuberculosis in man is not so much through the food products derived from our cattle as from other causes, namely, the close association of the healthy with unhealthy and the dried-up sputum of consumptives. In this respect our duty lies clearly in the direction of limiting all risk of infection to our fellow-beings, and minimizing, as far as we possibly can, losses in stock by the destruction of those animals which are centres of contagion. In the early part of this year the Shire of Wyndham caused the tuberculin test to be applied to seventeen dairy herds, 69 head of milking cows from these herds having been treated under this test by a careful operator. The temperature of these cows was taken five times before inoculation and five times after inoculation, and the test was conducted on the lines shown further on, with the result that none were found to react, *i.e.*, that no indication was given of the existence of tuberculosis. This extraordinary and satisfactory result is accounted for by the three bad seasons having cleaned off all affected animals. Our statistics as regards tuberculosis in cattle are most satisfactory as compared with other countries, but notwithstanding this fact, it is our duty to get rid of what disease we have, or by every possible means to confine it within narrow limits.

Condemnation of Tuberculous Carcasses of Cattle.

The rules prescribed for the guidance of inspectors in dealing with carcasses more or less affected with tuberculosis are the same as those adopted on the Continent of Europe, and are as follow :—

1. Condemn all wasted animals in which even a moderate amount of tubercle is found.
2. Condemn all wasted animals, no matter what their condition ; (*a*) when tubercles are found in several organs, whether softened or unsoftened, especially if both the chest and the abdomen are affected ; (*b*) when large masses of tubercle in an advanced state of softening are found even in one organ.
3. Do not condemn well-nourished animals on account of the presence of tubercles in the serous membranes only. In Prussia, Saxony, and Belgium it is laid down by Ministerial decree that the flesh of a tuberculous animal is to be passed as not injurious to health if the animal is well nourished and the tubercles are confined to one organ, or when only a few tuberculous deposits are found in the cavities.

Sanitation.

In Australia, where the sun's rays are so powerful in destroying the germs of disease, there is less difficulty in getting rid of contagion than in colder countries where cattle are housed and hand fed, and away from all sunshine. The sun is our great purifier and destroyer of disease, but over-crowding, imperfect ventilation, darkness and dirt favour the spread of disease, especially tuberculosis. Drains, yards, and sheds should be kept clean and sweet, and if not exposed to the sun's rays should be disinfected as often as possible. Contagion is also conveyed by infected animals licking others, and healthy animals licking affected ones, and the first step to be taken in a milking herd is to have such of those animals as show roughness of coat and dirty udders rubbed and washed. Every animal should be clean in every way before being milked, and the milker's hands washed and dried. These matters can readily be attended to without much trouble and loss of time, and if owners accustom themselves to them, they will in the end reap the reward that comes from the observance of such duties which in the main have not only a moral and healthful, but a commercial aspect. Where there is plenty of exercise and open air for cattle there is less disease, but in confined areas and dusty yards, where diseased animals have been, the dried particles containing the germs of disease are floating and wafted about, and are a source of danger to man and beast. This, then, shows that it is distinctly

the duty of stock-owners to remember that floating germs of disease are not only a source of danger by getting into the milk pail, but as affecting their cattle as well. No matter how quickly we get rid of tuberculosis in the living animal, if sanitary measures are neglected we shall always be in turmoil, hence it becomes necessary in any attempt to eliminate or reduce bovine tuberculosis or any other infectious disease, to begin at the beginning, that is, to see that all cows are clean and above suspicion before milking. Our stock-owners can afford to deal practically with all suspected cases of tuberculosis, *i.e.*, they can either isolate, tuberculin, or slaughter, and in one of my previous papers I pointed out that the tuberculin test applied to a herd, to be of any use, must be followed by slaughter, on account of the difficulty of separating reacting from non-reacting animals; the conditions of the open-air life of cattle in these colonies being different from those of European countries.

Tuberculin Test.

As a means of arriving at a speedy conclusion as to the nature of a suspected case of tuberculosis, the tuberculin test may with very great advantage be applied. It is now two years and a half since I set out, in a pamphlet, instructions as to how the test could be conducted, and it was suggested that suspicious cows, and suspicious bulls especially, should be tested, and if found to react they should be put aside for a time till further tested or slaughtered, and all inferior cows and heifers, whether tested or not, should be speyed and fattened for the butcher. There is no use in having breeding animals of known tuberculous taint, no matter how good their pedigree may be, and therefore it is of importance that care should be taken to find out the genuineness of the bull in the matter of freedom from tubercular disease. I am of opinion that it is here that the tuberculin test may play an important part, and here I think it well to recapitulate directions for its use.

Directions.

(1) The tuberculin must not be exposed to the sunlight. It must not be frozen. Must be kept well corked, to exclude air. (2) Dose and preparation for use—The above will vary with size and age, say from five to eight drops thoroughly mixed in nine times the quantity of a ½ to 1 per cent. solution of carbolic acid in distilled water. Thus: 5 drops tuberculin to 45 drops of the ½ to 1 per cent. carbolic solution, or 6 drops tuberculin to 54 drops of the ½ to 1 per cent. carbolic solution, or 7 drops tuberculin to 63 drops of the ½ to 1 per cent. carbolic solution, or 8 drops tuberculin to 72 drops of the ½ to 1 per cent. carbolic solution. Instruments necessary—One or more

Fahr. thermometers; a hypodermic syringe, with three strong hypodermic needles and a fine trocar; and a pair of curved scissors or snippers; a couple of minim measures; and three wide-necked stoppered bottles. Disinfectants—A 5 per cent. solution of carbolic acid in which to dip the instruments and hands; a 1 per cent. carbolic solution (as in direction 2), and a creolin solution to wash the skin with. When not to use tuberculin—When the atmospheric temperature is very low or very high; when the animal is suffering from any inflammatory disease; when a cow is bulling or far advanced in pregnancy; when the temperature of the body is abnormally high from any cause; when breathing impure air in a close, ill-ventilated building, or suffering from scarcity of water. The experiments should be conducted when the animal is cool and fully rested, and not when in an excited state or heated by exertion. Reliability as a test—While not infallible, it can be relied on in nearly every case where precautions are taken to use it in proper cases. A rise of over $1\frac{1}{2}$ degrees Fahr. will indicate tuberculosis; when the disease is far advanced no reaction will often follow its injection, owing to a superabundance of it already in the system. Taking the temperature of the body before injections—The animal must be kept in a temperate atmosphere of uniform temperature for several hours before taking the temperature. The temperature is to be taken every three hours during the day preceding the injection, say at 8 a.m., 11 a.m., 2 p.m., 5 p.m., and 8 p.m. The thermometer should be washed in a disinfectant solution before using on a fresh animal. Fahr. thermometers are only to be used, as they are most generally used in English-speaking countries. The normal temperature in the vagina is from 100 to 101·5 degrees. How to inject the tuberculin—The dilution being prepared (as in direction 2), carefully preserved from sunlight and air, let an assistant cut the hair close off any part of the loose skin behind the shoulder. Wash it clean with a creolin solution or 5 per cent. carbolic solution. Place the instruments with disinfectant 5 per cent. solution; rinse the hands in it also. Let the assistant make a puncture through the skin with the trocar, into which the operator will at once insert the needle of the hypodermic syringe (the object being to prevent the bending or breaking of the needle owing to the thickness of the skin), and inject into the cellular tissue the solution of tuberculin. The cool of evening is the best time to inject the test. Taking temperature after the injection—Commence at six o'clock in the morning, or earlier, and continue to take it every three hours; at 9 a.m., at noon, at 3 p.m., at 6 p.m., and at 9 p.m. Register the results in the charts very carefully. Precautions—The most rigid precautions must be taken to insure

that all experiments are conducted on the strictest antiseptic principles; and it should be particularly observed that when introducing the needle into Koch's tuberculin that it is rendered absolutely sterile, *i.e.*, placed first in absolute alcohol, and then immersed in carbolic acid solution. The delicacy of the test precludes its general application, there being so many things to be taken into account, the rise of temperature being but one element in the process of detecting the disease, and competent authorities say that other causes may come in to induce a temporary fever. I have simply indicated to you the nature of the test in order that you may be able to judge of its usefulness for yourselves, and further information will be found in my pamphlet.

Permit me here to bring under your notice that the tuberculin test was largely made use of a year or two ago by the State of Massachusetts, but it was found that, although tuberculin revealed the presence of tuberculosis, it gave no indication of the extent or gravity of the disease, and that it was simply ridiculous to kill any and every beast that reacted to the test where the udder was not involved. The practical methods now adopted by that State are to separate the suspected from the apparently healthy cattle, and see to the proper observance of sanitary measures; plenty of good food and water, proper ventilation, cleanliness, and disinfection. The Belgian Government, after some experience of the tuberculin test, and paying large sums by way of compensation, came to the conclusion a year or two ago that the value of tuberculin as a diagnostic agent was recognised, but unfortunately it drew no distinction between an animal with generalized tuberculosis and another with a single tuberculous nodule, and that its use for practical purposes had considerable limitations, that the attempt to stamp out tuberculosis in the native dairy stock had proved too onerous, and the cost intolerable. I think it well before concluding this part of the subject to outline some of the leading signs which lead to the detection of this disease.

Symptoms of Tuberculosis in Cattle.

The earliest signs in a typical case are loss of condition, a short dry cough occurring at indefinite intervals, and elicited readily if the animal is moved quickly. Usually the eye is dull and listless, or glassy and sunken, together with heaving of the flanks while the animal is not in an excited state. Such symptoms indicate the inroads on the system the disease has made. In such pronounced cases the hair is harsh and the skin hard and fast over the ribs, and if the lungs are affected the cough will increase in severity, becoming louder and hoarser, and at the same time the respiration is shorter and quicker. The milk decreases in quantity and quality, being poorer and bluish in colour. In

this condition the milk is not fit to be used, and should be boiled if it is to be given to the pigs, but the cheapest and wisest course is to slaughter at once all such animals, and so protect the other members of the herd from infection. The risk of infection is all the greater by allowing such animals to live longer than can be helped, especially where infectious matter is coughed up on to the pastures or other places, or where swellings of the throat and underneath the ear break and discharge. In the case of infectious matter being swallowed, the intestines and mesenteric glands become affected, so that there is nothing to be gained by delay, the first loss being always the best. Tubercle of the udder is a serious matter, indeed so serious that it should be regarded as a criminal act on the part of any man to milk a cow when he becomes aware of such a condition. There are so many inflammatory conditions of the udder that it is difficult to say whether tubercle exists or not until a microscopic examination is made or a test conducted, but to be on the safe side it will be well that the milk derived from cows having inflammatory udders be not used before being tested. A tuberculous udder shows a slightly hard, diffuse swelling, unaccompanied by heat or tenderness. The posterior quarter is usually attacked, and for a long time the milk remains normal, gradually becoming more and more serous and yellowish, and then small coagula are discharged which contain bacilli. Gradually the tissue becomes less supple, and the toughness increases to an almost wooden hardness. Cows with tuberculous udders should be at once destroyed. I may here add that the Victorian committee of experts reported that tubercle in the udder is, fortunately, not common, but, nevertheless, it is incumbent upon everyone to be careful, and leave no stone unturned if there is a doubt in the matter.

Post-mortem Appearances.

The parts most affected are the lungs, lymphatic and other glands, liver, spleen, uterus, lumbar glands, udder, trachea, intestines, ovaries, &c. On examining the chest, cutting first into the lungs, cheesy-looking patches may be found, and these vary in size in different carcasses, *i.e.*, there is no uniformity as to size and consistency, sometimes cheesy, soft, or calcareous, like mortar, whilst in other cases miliary tubercle, something like hemp seed in appearance, may be found throughout the whole of the internal organs. When the disease is well advanced or generalized, the surfaces of the lungs, chest wall, diaphragm, &c., may be studded with what is commonly known as "grapes," varying greatly in size. The next step is to see whether the glands above and behind the heart are affected, and if so, yellow, cheesy matter will be found, and if the air tubes are opened, tubercular appearances may also be present.

The Abdominal Organs.

The ingestion of tubercular matter through infected food is greatly the cause of abdominal tuberculosis, especially where abrasions occur; the intestines, liver, spleen, &c., and the omentum may be found studded with tubercular growths, the two main entrances being the mouth and nostrils, whilst occasionally infection is found to penetrate through a skin wound. The infective agent is the micro-organism termed the bacillus, and as propagation takes place, the parts first affected are centres of distribution throughout the animal's system when softening of the tubercles takes place, and in this case the animal becomes what is termed a

Waster.

There is, however, a strong opinion amongst members of the medical profession that many recoveries take place; that nature arrests the further spread of tubercle under certain conditions. They regard it as a curable and preventable disease, and do not countenance the indiscriminate slaughter of all animals reacting to the tuberculin test. The danger attaching to tubercular udders is so great that too much stress cannot be laid on this part of the subject. In Denmark it has been found that out of 100 tuberculous cows not more than three or four at the outside have tuberculosis of the udder, and I should like all owners whose cows have suspicious-looking udders to forward me samples of milk for test. I will now pass on to another subject, and say a few words on

Bovine Actinomycosis.

It is only comparatively recently that the various manifestations of bovine actinomycosis, or lumpy jaw, have been the subject of investigation, and now we know that it is a specific disease, caused by a fungus of a specific character. This disease is termed the "ray fungus," composed of combined structures of bacteria not growing as single individuals, but seen to the naked eye as spherical bodies about the size of grains of sand. They vegetate chiefly on barley (hordeum murinum), and are found between the vegetable fibres of broken particles of barley, which become imbedded in a carious tooth or in slight abrasions of the lining membrane of the mouth, caused by this and other kinds of food, such as mouldy straw, barley, and chaff. The lumps on the various parts, *i.e.* on the jaw, throat, tongue, &c., sometimes burst on to the pastures, which become fouled in this way, and healthy cattle contract the disease. It will be interesting to know the history of actinomycosis in other parts of the world in order that we may learn something in reference to causation, if possible, how it occurs in other countries, and the means adopted for its suppression.

In 1839 Professor Dick, of Edinburgh, published an account of an investigation into the nature of certain tumors in cattle, his researches, beginning from the year 1882, showing that in some parts of the north of Scotland cattle were very liable to this disease, especially in unsheltered flat country, and that it prevailed most in light dry soils in the summer time, the months of May, June, and July being the fatal months. Various theories at that time were held by farmers as to causation, one of which was that cattle were given too many turnips, and another that there was "something in the grass"; but the puzzle was to ascertain what that something was. The science of bacteriology in those days was unknown, but nevertheless intelligent observers held opinions which, I think, are worthy of reproduction at the present time One observer states that in the summer of 1828 his attention was directed to a number of young cattle that were affected with encysted or honeyed tumors situate on the throat at the superior angle of the lower jaw. When he first observed these tumors they were superficially attached to the cellular membrane of that part, and of course were easily removed by excision, which was the only treatment he found to be of the least use, but some time afterwards tumors were found to be firmly attached to the root of the tongue and cartilages of the throat, so much as to render their removal impossible. The effects of such tumors, he further remarked, were immediate falling off in condition and great difficulty in breathing; and when the disease was allowed to take its course the cattle generally died within four or five weeks after attack. This description clearly points to actinomycosis being the disease which in those days carried off large numbers of cattle in certain localities where it got a foothold, as it occasionally does in these colonies. To minimize loss some farmers cut out the tumors where the operation was simple, but where the disease was deep-seated at the root of the tongue, in the throat, and other parts, there was then, as now, no remedy. In certain parts where losses were constantly occurring, young cattle brought from healthy country contracted the disease, and in one instance, when a North of Scotland man bought fourteen head of young cattle in the month of May, 1828, he soon lost nine head. I simply mention such matters to show that the germs of the disease being in the pastures in certain seasons or at certain times of the year, there is great danger where diseased animals are, and that it is the duty of every one to protect himself and his neighbour from infection. This disease at that time was described as "wens clyers" or "crewels," &c., and men of eminence in those bygone days expressed the opinion that the cause of the trouble was due to the bite of some insect, or something in the blood. They, however, observed inbred cattle were more subject to "clyers,"

that is, lumpy jaw, than others, and were endeavouring to discover the best remedies to be employed. Professor Dick, about this time, made some valuable suggestions as to treatment under the circumstances, but it was not until the year 1860 that the true nature of the disease was observed, and the first accurate description of it—the ray fungus or actinomycosis—was furnished by Bollinger, in the year 1887. For 30 years, then, from Dick's investigation until the year 1860, various accounts are given by Professor Cruickshank, of London, of the different theories held and the various terms under which this disease was known. When it attacked the maxillary or jaw bone of the human family it was held by some that the remote cause was scrofula, while the existing cause was disease of the molar teeth. That eminent scientist traced for several years, beginning from 1841 to 1888, the progressive stages of inquiry that had been made concerning the several theories, and amongst other things he informs us that the tongue of an affected steer was sent to the Browne Institute, of London, for examination, with a view of finding out whether such affections of the tongue were due to a tubercular condition or not. The condition was found to be due to the vegetable parasite in question—the ray-fungus; so that although this disease was diagnosed in 1860, little was known of it up to 1882, when scientists began to feel their way, knowing that they were dealing with a disease in cattle and man new to science. At that time further inquiry was stimulated, and the question as to causation set at rest by further scientific tests, which showed conclusively that the vegetable parasite was the cause of the trouble.

Actinomycosis has been found to prevail to a very considerable extent in some parts of the continent of Europe, notably West Prussia and Russia, more largely than other parts, according to the large percentages that have been recorded, 20 per cent. in the former, and from 2 to 5 per cent. in the latter, whilst North America has been set down at 0·2 per cent. I may here point out that there does not appear to be sufficient information on the subject of the prevalence of actinomycosis generally in those countries, and as regards these colonies I am not aware of its real extent, since statistics have not yet been obtained, but I may safely say that outside the places known as the barley grass country the number of cases found is comparatively small. It is to some extent in cattle brought from the northern colonies, but those affected are not admitted here. We have no information as to how actinomycosis was introduced into this or other colonies, but we know there is a danger of it spreading through contaminated pasturage, and we have the experience of the Sutherlandshire farmers 70 years ago, whose ideas were that the cause was due to "something in the grass," and now science of

the present day tells us that that something is the vegetable parasite termed actinomycosis, or the ray-fungus, which vegetates chiefly on grain, the beards or horns of which penetrate the head and other parts of the body of the animal in various ways.

Treatment.

When in the northern portions of this colony some months ago I pointed out that the cause of prevalence of actinomycosis, or lumpy jaw, was greatly due to the series of dry seasons that we lately have had, and that when the good seasons returned, there would be less of this disease, and that it would not bear so heavily on stock-owners as it had done. This I find to be the case, and now there is very little of it to be found. The treatment is slaughter for those tumors deep seated, where there is a difficulty in removing them by an operation. As regards those tumors easy of removal, iodide of potassium has been found to be effective in a great many cases. The success of this drug depends greatly upon how it is used, and the quantities given. The internal treatment may be supplemented by the external application of iodide in the form of a tincture, or of Lysol's solution, either of which can be applied by means of a brush or injected sub-cutaneously.

The following is a general prescription for actinomycosis or lumpy jaw:—Medicinal—Doses: Potassium iodine, ½ drachm, night and morning. External applications—Lotion: Iodide 1 drachm, potassium iodide, ½ drachm; spt. vini. meth. 7 drachms; or the liniment of iodine of the British Pharmacopœia.

Surgical.

The swelling should be lanced at its softest and most dependent part, the contents evacuated, the cavity irrigated with an antiseptic, after which it should be plugged with cotton wool, saturated with liniment of iodine, and this treatment is to be carried out every day. The cavity in the end fills with granulation, and the resulting enlargement usually disappears in time. Hard and schirrhus tumors require more attention.

This disease fortunately is dealt with in this and other Australian colonies by treating it as a contagious disease for the purposes of the Act. We have power to deal with cases that require to be dealt with even from a humane point of view. In advanced cases where emaciation sets in, especially in an advanced stage, animals in this condition have no right to live a day longer than can be helped. At this stage they are particularly dangerous to the stock-owner, and are totally unfit for food. They are "wasters," and should be destroyed by fire,

and the pastures on which they have been running should be disinfected as far as practicable. Animals in the early stages may be treated as already pointed out, and allowed to fatten. If any doubt exists as to the extent of the disease, the affected animal may be quarantined if necessary, or simply isolated, or sent to the slaughter-yards and killed under supervision. And if only slightly affected or localized, *i.e.*, where the tumors are confined to the head and under the jaw, the head is destroyed, and the carcass, if in good sound condition—well nourished—is passed as wholesome and fit for consumption. It is much cheaper to have animals of no great value destroyed, rather than go to the trouble and expense of attempting to treat cases where the disease is well advanced, and it is a good maxim to remember that the first loss is always the best loss, and many owners who are keenly alive to their own interests observe that truism religiously.

In conclusion, I must in a few words refer to those diseases which threaten us from the other colonies, and say that there is every good reason for us to be on the alert to see that every precaution is taken against their invasion, and, if they invade, to keep them in check until conquered. I refer to the Queensland tick and anthrax. I have been in great hopes of inoculation being a safe and protective agent, and that in the event of the ticks reaching New South Wales we should have a safeguard in this measure. It would appear, however, that inoculation is on its trial as regards its being a safe measure, as it is stated that the inoculating material or blood, taken from a beast recovered from the tick fever, contains the micro-organism which sets up the fever, and that inoculated cattle are a source of danger to uninoculated cattle through the medium of non-virulent ticks, or it may be other insects. It has been found in some parts of Queensland that they have cattle affected with the cattle tick and that such ticks have not set up the tick fever or "redwater," but that when they are placed on inoculated cattle they become pathogenic, *i.e.*, they become disease-producing ticks when attached to healthy cattle. Unless, therefore, inoculation were generally practised, the fever might be communicated to healthy cattle in various ways. Further experiments to test this matter are recommended by the New South Wales Royal Commission to be made and the length of immunity is conferred by inoculation.

Regarding the subject of anthrax, vaccination has proved to be a protective measure, and regulations bearing on this subject are now gazetted requiring that sheep especially should be guaranteed to come from districts free from anthrax, or if they come from affected parts or travel over affected areas, they have been vaccinated within a reasonable time by a recognised expert

whose certificate is to be produced to the Victorian inspector on the border. We cannot be too particular in these matters ; at the same time, it is difficult to carry out measures of a restrictive character without some one feeling their effects, but when it is known that national interests must prevail, owners and importers of stock will readily see the wisdom of precautionary measures being adopted where they are needed. I trust I have not overtaxed your patience on subjects which are of great importance to you in your industrial pursuits, and am quite sure that the more you study and observe the different matters devolving on you as practical men, in doing this you will set a good example to those of less experience, and in this way you are moreover doing good. I have avoided repetition of remarks made by me on these subjects on former occasions as much as possible, in order that the fullest information may be given collectively.

REPORT BY THE ENTOMOLOGIST (C. FRENCH, F.L.S., F.R.H.S.).

In submitting my report for the year 1899, I may state that the excellent plan adopted by many entomologists in America, and in the colonies, of including in their annual report illustrations of the various destructive and beneficial insects found during the year, has here been departed from; this is owing to the fact that Part III. of the *Handbook of the Destructive Insects of Victoria* will appear almost simultaneously with this report, so that a repetition appears unnecessary.

In a few instances, as in the "Fruit-flies," "Green-Moth of the Apple," &c., which were not ready for inclusion in Part III., they are herein enumerated, so that growers—should the above-named insects make their appearance in the orchards—may be able to recognise the specimens when seen, and, by means of the advice given, be able to deal effectually with the same.

It is my wish, with your permission, to complete the "work" upon which I am engaged in six parts, the last dealing specially with beneficial insects, many of which, as has been seen in America and elsewhere, play a very important part as "helps" to the grower, and these should be protected as far as possible from destruction.

Experiments in the field, as will be shown elsewhere in this report, have not received the attention which such highly important matters deserve, there being no time available for the carrying out of the same, although many valuable observations have been made by my assistant, the inspectors, and myself; the inspectors being constantly travelling amongst the orchards, and through the colony generally, are thus able to render good service in this direction.

It is hoped that, with extra assistance, this important work will be more in evidence during the forthcoming year than it has been in the past.

General Progress.

The work in this branch of your Department is rapidly growing, both in magnitude and in importance, and judging by the support accorded to it by the public and by the press it would appear to be extremely popular.

The number of specimens submitted to me for examination and report has been very large, and as many of these have to be carefully, and often microscopically, examined, it will be seen that this portion of my duties entails a vast amount of labour, to say nothing of the time taken up in critical observations and research.

Reports have been supplied to the Department on numerous subjects, the principal being a report on the noxious weed known as St. John's Wort; report on the discovery, by myself, of Phylloxera in the Rutherglen District; report on state of Phylloxera-resistant Vines at Rutherglen College; report on Locusts; report on the Working of the Vegetation Act; San José Scale, &c., &c., &c.

The old trouble experienced through receiving imperfect specimens for examination is constantly cropping up, and, as it is just as easy to forward whole specimens as it is to send unrecognisable fragments, it is hoped that better results in this direction may be obtained in the future.

In forwarding insects through the post, which is the best and most expeditious method, the best plan in the case of the larger beetles is to kill these either by immersion in alcohol or by throwing them into boiling water; but if the latter process be adopted, the specimens should be slightly dried before sending. Caterpillars or grubs should be packed (as indeed all should be) in tin boxes, and in the case of caterpillars a little grass for the ordinary kinds will suffice, but, for those which live below ground, soil should be placed in the box before sending.

Moths may be sent with their wings folded in the corner of a used envelope, which can be packed in a separate box, so as to prevent damage to the specimens. Minute kinds of insects, as some beetles, &c., may be enclosed in a small phial or test tube, and packed in an outer box as above described, and, in the case of living insects, small air-holes should be made in the box before sending it. In forwarding boxes by post, a tag should always be used, containing the stamp and address, in order to prevent damage to the box

by stamping at the post-office. Scale insects may be packed in bottles enclosed in an outer box, as, if not carefully packed, the young scale may escape. In killing insects, entomologists usually use either cyanide of potassium or chloroform, but for persons living in the country, and for children, its general use is not recommended, the former material being one of the most deadly of poisons, and bottles so prepared should only be handled by adults.

All specimens sent should bear the date of capture, brief observations, and the name and address of the sender, when the matter will, if possible, be at once attended to, and a reply sent.

Correspondence.

This is, perhaps, the most formidable item in the day's work, and as there are four deliveries during the day, Saturdays excepted, it will be seen by the returns of correspondence replied to and entered in the office letter-book, that a vast amount of time is taken up with matters of this kind, which in a large measure require my personal attention and reply. This correspondence is by no means limited to our own colony, and I am in constant communication with Europe, with America in particular, and other countries, as also with the whole of the Australian colonies, the number of letters entered during the year being 1,985. In the matter of routine correspondence, I am ably seconded by my assistant, Mr. C. French, junior, who in and out of office hours assists materially in lightening my task in this respect. In corresponding with clients, it frequently happens that specimens difficult of identification are sent, and thus an examination may take hours, so that correspondence frequently involves a somewhat lengthy and tedious examination. As a rule, all correspondence is replied to, if possible, on the day on which it is received, thus enabling one to have a "clean sheet" for the following morning. This practice, although it often entails encroachments on my spare moments, has given general satisfaction to those seeking information, and has frequently been acknowledged by the recipients.

Literary Work.

Under this heading is included the publications "Guides to Growers" and Part III. of the "Handbook of the Destructive Insects of Victoria," but owing to the large

number of specimens submitted to me for examination, and of applications for advice, it has been found impossible, at any rate during office hours, to devote much time to work of this character; still, I have been able to issue several pamphlets, viz., one on the "San José Scale," "Fruit Flies," "Root-borer," &c. Part III., which is now in the hands of the Government Printer, will comprise about 200 pages of letterpress, with 30 coloured plates of insects and insect-destroying birds, engravings of new spraying machines and material, &c., with the life histories of the insects and birds enumerated. This part is one of a series, Parts I. and II. having been published at intervals, and the first part of 9,000 copies was rapidly disposed of, and of Part II. the sale has also been large. It is gratifying to know that this work has been most favorably reviewed by the whole of the colonial press, also by the leading newspapers and rural journals of Europe and America. It may be stated that the plates for the forthcoming part have been mostly drawn under my direction from nature, the artist being, as before, Mr. C. C. Brittlebank, of the Field Naturalists' Club, who is himself a naturalist, the successful sale of this "Part" of the book being already assured.

The want of an artist permanently connected with the branches is badly felt. In Sydney, and in most other places, an artist is attached to the Department, and his services are divided between the various branches as required there; as it often happens that specimens become shrivelled and otherwise deformed before the services of an artist can be obtained. I beg to urge this matter for your consideration.

Investigations and Experiments.

It has been previously mentioned that there has been little or no time available for work of this kind, the extra duties which I have been called upon to undertake, the nature of which is explained elsewhere, render it impossible for me to personally supervise experiments which may be of the greatest importance to the fruit-growing industry. I may, however, state that opportunities for experiments by the various inspectors have not been overlooked, one of the most important being the experiments carried out by Inspector Cock, under my directions, with the "Locust Fungus," which was introduced from South Africa by this branch of your

Department, and the life history of which is now being worked out by my colleague, Mr. McAlpine, Government Vegetable Pathologist. It is gratifying to know, however, that after repeated failures, owing chiefly to the heat and dry atmosphere of the northern parts of the colony, the fungus, as a locust destroyer, has at last proved a success, and we hope to use it on a larger scale; also on grasshoppers. It is hoped that time will permit of this matter, so momentous to those engaged in rural pursuits, being followed up, as we all know what a fearful scourge the locust visitations are. A full report of the above experiments may be found in Part III., which will shortly be available to the public.

Experiments made on the "San José Scale" at Wangaratta and Rutherglen, favour the hope that this pest will be speedily stamped out, or at least kept in harmless subjection. No pains will be spared in the eradication of this dangerous insect, the introduction of which has been traced to a firm of Sydney nurserymen. At present, and owing to vigilance exercised, this scale is rapidly diminishing, and as there are no nurseries within a long distance of the small areas infected, it is felt that by constant supervision, which will not be relaxed in the slightest degree, the "San José Scale" must disappear.

In America each state has its chief entomologist and staff of specially trained field-workers, whose duties are to make observations, and conduct experiments, the results of which are in turn communicated to the entomologist for his information and subsequent use in his annual report, and it is in this branch of Economic Entomology, that much of the most valuable work is being done. In a comparatively young colony such as ours, it cannot be expected that such splendidly equipped institutions as are commonly to be found in America can at once be established, still we have ample scope for an almost illimitably useful field of research, the results of which would no doubt prove of incalculable value, especially to those engaged in fruit-growing and other rural pursuits. A study of the life history of any insect, being, to the economic entomologist especially, of the greatest possible value, since it enables him to furnish advice as to the precise time when the insects in their various stages are best attacked, thus effecting a saving of much time, expense, and unnecessary labour.

Museum of Economic Entomology and Ornithology.

The museum attached to the office here, was commenced by myself, the nucleus of the fine collections now on view having been donated from my private collection, and owing to the liberality of the Department, which has permitted the purchase of the splendid South Kensington Exhibit of the life-history series of British insects, and other acquisitions, coupled with constant donations from correspondents and from my assistant, we are now in the possession of the most complete collection of Economic Entomology in the Southern Hemisphere, the museum having during the present year been largely patronized by schools, students, growers, and others requiring information from this branch of your Department.

These collections are almost constantly being added to; the rearing of insects forming one of the special features in connexion with the museum, the periods from egg-laying to the appearance of the perfect insects being carefully noted for reference and subsequent use.

The specimens, which number many thousands, are all enclosed in tightly fitting glass cases, so that students can easily examine the insects contained therein, the collection being so arranged as to admit of their being understood even by the uninitiated.

The Ornithological collection is arranged in glass cases, and comprises the great majority of the insect-destroying birds of the colony, these being all scientifically named, with the common name of each attached, the combining of the insects and birds having been based on the sensible and up-to-date system practised in similar museums in the United States; a recent visit from two distinguished American economic entomologists confirming the high opinion in which this collection is held by those competent to form an opinion on such matters.

In addition to the birds themselves, the nests, and eggs where possible, are shown, the latter having been presented by my assistant, who, besides taking a special interest in such matters, has charge of the collections, much of their material having been collected by him and by myself during holidays and other spare hours, the remaining portion of the collection being principally charts, dissections of insects for the use of schools, timber specimens showing the ravages of insects, spirit specimens, &c., &c.

Library.

The office library founded by myself, which, from an economic point of view, is one of the most complete in the colonies, contains upwards of 1,000 bound volumes, and to which, owing to the liberality of the Department, I am able to add, to a reasonable extent, by the purchase of such up-to-date works as I require; each book as it is received being stamped and catalogued, and in this connexion especially I desire to acknowledge much valuable assistance given by my late assistant, Mr. D. M. Dow.

The books are available for the use of students of economic entomology who wish to consult them at the office.

As works of reference, this library is invaluable, and is much appreciated by those working in the direction above indicated. Works on Botany, and especially Mycology (Fungi) are also well represented, as, although my colleague, Mr. McAlpine, has charge of the important Vegetable Pathology Branch of your Department, there are occasions on which such works have to be consulted in relation with many food plants of certain insects, thus rendering necessary the inclusion of such books in the library.

Constant exchanges of our publications for those of other countries is actively kept up to the mark, as it is chiefly by the aid of such publications, that one so far removed from the old world centres is enabled to keep abreast of the times.

Greater Britain Exhibition.

The preparation of an exhibit from this branch for the above festival caused a deal of thought; and much time was spent in getting together a good representative exhibit, such as would do credit to the colony and to the Department of Agriculture. The collection, which was got up in the best style, comprised six frames of plates from Parts I., II., and III. of our *Handbook*, four case-frames illustrative of insect architecture, and directions for teaching purposes, two glass cases of timber specimens, showing the ravages caused by insects in timber, orchards, &c., one case containing 50 specimens of the best of the insect-destroying birds of Victoria, two cases containing nests and eggs of same, the latter prepared by my assistant, and copies of Parts I. and II. of the *Handbook of the Destructive Insects of Victoria*, these collections having excited much interest in London, and obtained two first awards of merit.

Legislation.

Vegetation Diseases Act.

This Act, which came into operation on 2nd March, 1896, has been dealt with in a report furnished by the Central Board of Advice incorporated herewith :—

REPORT ON THE WORKING OF THE VEGETATION DISEASES ACT 1896.

Objects for which the Act was framed and passed by Parliament.

The Vegetation Diseases Act, which came into force on 2nd March, 1896, was passed at the instigation and in the interests of the fruit-growers of the colony with the object principally of advising orchardists, nurserymen, and others as to the best and most economical methods of keeping their places free from insect and fungous diseases ; also to enable them to place their produce on the market in the best condition possible. It was also felt that whilst many persons exercised great care, and went to much expense in keeping their places clean, there were many who did not take this trouble, consequently rendering the efforts of those people inoperative ; in which case the Act enables the Department to take action and compel these persons to keep their orchards, &c., free from disease.

Appointment of a Central Board of Advice.

The Governor in Council, under section 13, sub-section (*e*) of the Act, appointed a Central Board of Advice on the 15th May, 1896, consisting of Messrs. J. Harris, M.L.A. (chairman), the Hon. W. Anderson, G. Neilson, C. French (Government Entomologist), and D. McAlpine (Government Pathologist). Regulations under the Act were framed by this Board and approved of by the Governor in Council. The first meeting of the Board was held on 14th May, 1896, and meetings have been held regularly ever since. The Board felt the loss of Mr. Neilson's services by death in January, 1898. His services were of great value, and the vacancy caused by his decease has not yet been filled.

Regulations.

The regulations provide for the steps to be taken by growers and importers in dealing with disease ; the duties to be performed by inspectors ; the manner of appointment and election of local

boards of advice with their duties ; instructions to persons dealing with the scheduled diseases ; dividing the colony into fruit-growing districts ; and for the inclusion of insect and fungous diseases under the Act.

So as not to make the working of the Act too cumbrous at the start, only as few diseases as it was found actually necessary at the time to proclaim were gazetted, viz., five (5) insect diseases and three (3) fungous diseases. As occasion arose more were added, and approved by the Governor in Council, viz., five (5) additional insect and two (2) additional fungous diseases ; the total at the present being ten (10) insect and five (5) fungous diseases. Others will be added as circumstances arise.

Local Boards of Advice.

The regulations provide for the appointment of a local board of advice for each fruit-growing district by the fruit-growers, who are at liberty to register their names with the returning officer for each district. This course has not so far proved a success, owing to want of interest on the part of the growers themselves, except in five instances. Out of ten districts only five complete boards were elected by the growers, notwithstanding the fact that each board was to consist of seven members only.

We think that this difficulty might be met by the local boards of advice being made nominee boards, appointed by the Governor in Council, and would recommend that the Act be so amended as to provide for this. We would further recommend that an amendment be also made in the direction of compelling every fruit-grower in the colony to register his name with the returning officer for the district in which such fruit-grower resides. This step would facilitate the work of the inspectors in making their examinations of orchards as thorough as possible.

Appointment of Inspectors.

The colony having been divided into ten (10) fruit-growing districts, it was thought necessary by the Board to appoint one inspector to each district ; and to make the system of inspection as thorough as possible a staff of at least twelve (12) inspectors would be required. This course was recommended to the Minister of Agriculture. As a commencement two (2) were appointed, the date of the first appointment being 19th February, 1898. Since then the staff has been added to from time to time until at the present time the number has been increased to seven (7) fully qualified inspectors, with two (2) temporary junior assistants for city work. The whole of these, with the exception of the two juniors, were appointed from other departments of the civil

service, all being required to pass a competitive examination in practical entomology and mycology, &c., &c., the examiners being Messrs. French and McAlpine. The inspectoral staff has been attached to the entomological branch of the Department of Agriculture, with Mr. C. French as Chief Inspector.

Inspections.

Orchards, Nurseries, and Gardens.

Upon examination, many of the orchards, &c., of the colony were found to be in a more unsatisfactory state, as far as diseases were concerned, than was expected. Up to date 3,800 places have been visited by the inspectors, who have given the necessary instructions. In addition, a number of these have been revisited, to see if their instructions have been carried out. In four cases it has been found necessary to institute proceedings against occupiers for non-compliance with regulations, in each of which cases the prosecution was successful. Further, some orchardists at first showed an unwillingness to comply with instructions; but, after serving them with notices to clean, satisfactory results were obtained.

Nurseries.

The system inaugurated of inspecting nurseries, and of issuing certificates to clean, has been found to work well; 47 nurseries have been examined and granted "clean certificates," which hold good for six months. The other colonies accept our certificates of cleanliness accompanying trees sent. This not only facilitates the work of the inspectors, but the improved condition of our nurseries is noticeable in a marked degree. The number of certificates issued by the Government Entomologist on nursery stock exported from the colony is 1,600, being an average of about 1,000 per annum. There are also a number of nurseries that only grow cut flowers for market, and, although they are generally clean, it has not been found necessary to issue them "clean certificates."

Abandoned Orchards.

Some three years since, at the suggestion of the Government Entomologist, an estimate was made of the number of acres of abandoned orchards within a 10-mile radius of Melbourne, and it was found that there were something like 700 acres, at a low estimate. These orchards consist of land on the outskirts of the suburbs, purchased by land syndicates in the boom time, with the object of their being cut up into building allotments for sale. These are now being dealt with. Great difficulty exists in dealing with them and in finding the owners of the places, many of which are unoccupied and still owned by syndicates. They

are a menace to genuine orchardists, being veritable breeding-grounds and nurseries for noxious insects and fungi. One inspector is occupying the whole of his time in examining these. We hope that before long these abandoned orchards will cease to exist, the Act giving the inspectors power to destroy all trees which are past redemption, after serving notices on the occupiers or owners.

Fruit Importation.

Whilst compelling all fruit-growers to eradicate disease, the Board found that there was great danger of their efforts in this direction to some extent being nullified, unless strict supervision were exercised in the examination of fruit and fruit trees imported. As showing the nature of this work of inspection at the wharfs and rail stations, the whole time of one inspector and two assistants is devoted to this work. In Queensland and New South Wales great damage is done to fruit by two species of fruit flies —the Queensland and European. Great apprehension exists amongst our fruit-growers for fear of the introduction of one or both of these pests. Up to the present time, owing mainly to the strict supervision exercised by our inspectoral staff, neither of these pests has made its appearance. The magnitude of this work will be realized when it is stated that during the fruit season 468,154 bunches of bananas were imported by sea into the colony ; 13,775 bunches and 911 loads of refuse having been condemned and destroyed up to date on account of disease. Of citrus fruits alone 334,260 cases have been imported up to date, of which 11,832 cases have been condemned and allowed to be transhipped elsewhere.

In the case of citrus fruits imported from the other colonies, certificates as to the same having been treated with hydrocyanic gas under Government supervision must accompany such fruit before it can be admitted, we reserving to ourselves the right of inspection, even if the fruits are so accompanied. In the case of bananas and other soft fruits, which could not be so treated, each consignment must bear a certificate to the effect that it has left the port of shipment in a clean condition. The general improvement in the fruit imported (except in the case of citrus fruits from New South Wales) is very marked, especially with citrus fruits from the continent. In view of the danger which exists of introducing on trees new diseases into the colony, a cyanide chamber has been erected at the Horticultural Gardens, Burnley, to which all imported trees are sent, and there treated for one hour. Owing to the distance of this chamber from Melbourne, it is found that the importer has to put up with much inconvenience by having to send his trees there to be treated. The Board is of

opinion that a disinfecting plant erected at some place more convenient to the port of landing would be more advisable. This treatment of trees has been found by experience to be very fatal to all insect life, especially and if properly managed without injury to the plants. In the retail fruit trade there is yet much to be done. We think that a systematic inspection of fruit shops and markets should be made. A large amount of inferior fruit is offered to the public in these places ; and, although such fruit is not necessarily diseased, it is much below the standard of what should be expected in Victoria.

The use of old and second-hand cases is much to be deprecated, and, as these are undoubtedly the means of disseminating disease, the importance of this matter cannot be overrated. All cases before being used a second time should be thoroughly disinfected, and cases not disinfected should be destroyed. Each grower should possess the necessary means of dipping his cases, according to clauses 7 and 9 of the regulations.

Export of Fruit.

The export trade in fruit to the other colonies has been very large, and demands constant attention by the inspectors. The Governments of other colonies insist on fruit received from Victoria being accompanied by a certificate from our inspectors that it is free trom disease when shipped. This entails a great deal of work on our staff. So as not to put the exporter to inconvenience much of this inspection has to be done outside office hours, at all times during daylight.

General Remarks.

On the whole we find that the Vegetation Diseases Act has been of great benefit to the colony. Monthly reports from inspectors to the Board show that growers are fully alive to the importance of producing nothing but sound and clean fruits. They are always willing to adopt suggestions made by the inspectors, and show great appreciation of the trouble taken to afford them instruction, not only in the orchard, but also by means of lantern lectures. It is only fair to the inspectors to say that they have shown much aptitude for their work. The scope of our inspection is much more advanced than that of the other colonies, Tasmania and South Australia with Victoria being the only ones which make orchard inspection a feature of their work.

It has been found that there are many plants growing in our public parks, gardens, and reserves diseased ; and a thorough inspection of these has been made, the attention of the curators in each instance being directed to the urgent necessity of eradication of all disease. There are also many private gardens in the

colony, both large and small, in which occur a few fruit trees. Many of these cases, which are amongst the worst, are being dealt with, but owing to their being numerous and so scattered, the matter of dealing with them is necessarily difficult, and they will take some time to be effectively dealt with.

To make the Act more effective it is necessary that the staff of inspectors be increased to the number originally recommended by the Board, viz., twelve. There are now only seven (7), and they have to spend a large amount of their time in Melbourne, inspecting both exported and imported fruit. The export of fruit is increasing year by year, and there is every probability that it will reach very large dimensions.

So far there has been very little friction in working the Act; and as we are looking forward to a large expansion of our fruit-growing industry, we are of opinion that, seeing there is a permanent measure in each of the other colonies for dealing with diseases in fruits, the continuance of this Act is fully justified, and that it should be made a permanent measure.

On behalf of the Board,

JOSEPH HARRIS,

10th August, 1899. Chairman.

Owing to the fact of the whole of the inspectoral staff having been attached to this branch of your Department, the responsibility of the greater portion of the practical work connected with the Act and its provisions naturally devolves upon my office, the time thus occupied greatly diminishing the efficiency of the more important work with which I have been entrusted, and have undertaken to carry out to the best of my ability. Included amongst the many duties involved in the supervision of the work of inspection is the mapping out of the districts and places to be examined, the paucity of inspectors rendering it impossible to confine the work of the inspectors to separate districts, as was originally intended. Correspondence with inspectors and orchardists who require their services, checking of reports, travelling expenses, journals, attending meetings of the Central Board of Advice, regulating the inspection of fruit imports and exports, and numerous other matters connected therewith, demanding much careful and prolonged attention.

As showing the scope of the work to be carried out, I may mention that the number of orchards visited up to date is close on 4,000, and the number of certificates issued during the year to nurserymen alone numbered over 1,000.

The fruit inspection is now assuming formidable proportions, and to prevent, if possible, the fruit fly being introduced into the colony from Queensland, and from New South Wales more especially, "double inspection" is often resorted to. As showing the magnitude of the fruit import and export examination, it may be stated that for the year 1899 the following numbers passed through the hands of our inspectors, and the trade is decidedly on the increase.

Imports and Exports during 1899.

The report under the Vegetation Diseases Act only accounts for those passed up till July, 1899.

IMPORTS.—1st JANUARY to 31st DECEMBER, 1899.

Fruit.	Passed.	Condemned.	No. of Certificates Issued.
Bananas, Queensland	582,184 bunches	7,290 bunches 790 loads refuse	178
" "	757 cases	29 cases	6
" Fijian ...	511 "	Nil.	20
Oranges	230,589 "	2,632 cases	1,591
Lemons	29,032 "	2,936 "	516
Pineapples ...	18,930 "	66 "	365
Tomatoes	10,268 "	1,978 "	150
Apples	7,085 "	15 "	96
Peaches	3,561 "	314 "	57
Plums	1,246 "	Nil	92
Black currants ...	1,222 casks	"	33
Apricots	1,259 cases	"	26
Gooseberries ...	362 packages	"	9
Strawberries ...	773 crates	"	743
Loquats	508 cases	"	24
Passion	2,934 "	"	195
Raspberries ...	207 "	"	5
Limes	492 "	388 cases	2
Cherries	78 casks	Nil	15
Blackberries ...	293 "	"	15
Granadillas ...	15 cases	"	3
Shaddocks ...	22 "	"	4
Pears	151 "	33 cases	3
Mangoes	37 "	Nil	12
Persimmons ...	10 "	"	1
Grapes	15 "	2 cases	7
Nectarines ...	611 "	48 "	21
Quinces	21 "	Nil	1
Miscellaneous fruits	296 "	"	38
Plants	785	2	355
Total ...	894,254 packages	16,515 packages	4,583

EXPORTS.—(TO AUSTRALASIAN COLONIES ONLY).
1ST JANUARY TO 31ST DECEMBER, 1899.

Fruit.	Number of Cases Inspected.	Number of Certificates given.
Bananas—Queensland ...	15,327 cases ...	2,327
" Fijian	511 " ...	20
Oranges	15,201 " ...	1,323
Lemons	9,819 " ...	826
Cherries	20,280 " ...	842
Pineapples	2,372 " ...	519
Apples	3,628 " ...	142
Pears	17,190 " ...	450
Plums	2,959 " ...	101
Apricots	4,143 " ...	227
Peaches	1,035 " ...	147
Grapes	1,619 " ...	136
Tomatoes	519 " ...	82
Quinces	305 " ...	18
Passion Fruit	301 " ...	62
Gooseberries	216 " ...	20
Raspberries	120 buckets ...	6
Strawberries	105 crates ...	12
Red Currants	29 cases ...	3
Black Currants	26 " ...	4
Nectarines	43 " ...	16
Figs	70 " ...	5
Loquats	6 " ...	6
Miscellaneous Fruits ..	389 " ...	56
Plants	2,114 " ...	1,059
Total	98,417 cases ...	8,409 certificates.

In the case of tomatoes, from Queensland and New South Wales, a recommendation has been made by the Board to the effect that their importation be prohibited, the fruit fly having been reared by myself from tomatoes infested with the larvæ or grubs of this terribly destructive insect, and in such cases the fruit has been destroyed by steaming, in the boiler which is available for such purposes.

How it happens that the fruit fly has not yet, so far as we are aware, obtained a footing in Victoria is a mystery; it being in Queensland, New South Wales, West Australia, and in Tasmania. The inspection, as carried out here, is as perfect as it is possible to make it; still to examine every single fruit is of course a sheer impossibility, more especially when it is no unusual occurrence for 10,000 bunches, each containing from ten to fourteen dozen of single fruits, to be landed on the wharf at one time, to say nothing of the risk incurred through persons bringing fruit in their luggage, &c.

It is assuring also to know that, although the Act has been in force since 1896, and such a vast amount of work has been done, as well in the orchards, nurseries, as on the wharfs, and at the railways, very little friction has occurred, it being recognised that the Act was passed for the common benefit of all concerned, growers, importers, and shippers being alike protected by its provisions.

I must here acknowledge the valuable assistance rendered by the Customs Department, without which the labour of the inspectors would have been considerably increased and rendered more difficult.

The inspectors, one and all, are most assiduous in their duties, and with eyes trained by experience, it is presumed that very little disease escapes their notice ; discretion in the exercise of their duties being one of the many conditions imposed upon them by the department.

The export of fruit to places outside the colony is yet in its infancy, but the possibilities of success and extension are great, and as the matter of inspection has been committed to my branch, I hope to place the examination of the fruit exported on a sound and practical footing.

FUMIGATION.

Hydrocyanic Gas Treatment.

Dr. Coquillet was the first to suggest and use this gas for the destruction of scale insects. His experiments, according to Professor Lodeman, began in September, 1886, in the orange grove of J. W. Wolfskill, of Los Angeles, California. Its use has been followed by such good results that all other gases have been abandoned in treating these pests. The gas is prepared by using—

Cyanide of potassium, 60 per cent.	1 ounce.
Commercial sulphuric acid ...	1 fluid ounce.
Water	3 fluid ounces.

Potassium cyanide of 90 per cent. has also given excellent results. The water is first placed in an open glazed vessel, and then the acid is added. When the parts to be treated are all covered, the diluted acid is placed under the tent, the cyanide of potassium is dropped in, and the tent immediately closed. The gas is exceedingly poisonous, and should not be inhaled. The amount formed with the above materials is sufficient for a confined space containing 150 cubic feet. It

is safer to use the gas upon dormant trees, and during cool weather, or at night, since trees are more easily injured during a high temperature. The parts treated should remain covered for about an hour, and, to make the remedy most efficacious, several tents should be in use at once, so as to prevent loss of time on the part of those engaged in the operations of fumigation. The following table, giving the height of trees and the proportions of chemicals and water, will be found suitable for districts in the interior or beyond a radius of ten miles from the sea coast :—

Height of Tree.	Diameter through Foliage.	Water.	Sulphuric Acid.	Cyanide of Potassium.
Feet.	Feet.	Fluid ounces.	Fluid ounces.	Ounces.
6	4	2	1	1
8	6	4	2	2
10	8	6	3	3
12	10	10	5	5
14	14	16	8	8
16	16	18	9	9
18	16	20	10	10
20	16	22	11	11
22	18	24	12	12
24	20	26	13	13
26	20	27	13½	13½
30	20	28	14	14

One would suppose that an (orange) tree having a dense foliage would fill up the space within the tent, and require less gas to be effective. But the cold surface of the leaves condenses the gas, and fumigators find that a slightly heavier charge of chemicals is necessary for such a tree, and where the foliage is scant a less amount than is given in the table will answer. Some orchardists and fumigators consider that the work has not been effective unless some of the leaves or tender twigs have been injured. This is not necessary, for in our early experiments we have treated trees and killed the scale without injuring even the most tender twig or blossom. As the trees recover very quickly, even when seriously scorched, a slight burning is not detrimental and is an evidence that the work has been effective, except in the case of "black scale" (*Lecanium oleæ*), during the early summer when the eggs are under the females. The proper time to fumigate for this scale is during the fall or early winter, when they are in the larval state.

In order to render the canvas used for fumigation perfectly air-tight, so as to prevent the gas escaping, the tents have been treated with a light coat of linseed oil which was objected to on account of its stiffening the canvas and adding considerably to its weight, so a cheaper and more flexible preparation was sought. The following mixture, used by Commissioner Scott of Los Angeles, California, during the past season, made the tents gas-tight and left the canvas soft and pliable:—"The chief essential ingredient is a supply of common 'prickly pear cactus' (Opuntia Engelmanni) that grows in abundance in the southern countries of the State. It is a flat-leaf species, and parties living in sections to which it is not indigenous, could have it sent in boxes. To make the cactus extract, chop up enough cactus to fill a barrel two-thirds full, then fill up with a barrel of cold water. It should stand for 24 hours when it will be ready for use. Do not prepare more than is required for immediate use, otherwise it will become sour and worthless. Stir well, then strain ten gallons of the liquid into another tub or barrel; dissolve two pounds of common glue and add to the cactus extract sufficient yellow ochre or Venetian red to give it a good body. After thoroughly mixing the ingredients it is ready for use. Both sides of the canvas should be painted, and the dressing well rubbed into the fibre with a flat paint brush. It is possible that our common 'prickly pear' (Opuntia) might answer the same purpose, at any rate it would be worth a trial, as plenty of material could be easily obtained here (C.F.) If oil is used the canvas should be spread out and thoroughly dried before it is rolled up, or it is liable to be destroyed by spontaneous combustion. When dry there is no danger of this."

The above has been taken from the *Bulletin of the Californian State Board of Horticulture*, the information having been prepared by Mr. Craw, whose opportunities for experimenting, and general knowledge of the whole matter, enable him to speak with authority on the gas-tents and their practical use for orchard work especially.

In Part I. of our handbook, several pages are occupied by descriptions of the various kinds of fumigating apparatus, together with illustrations of the same, these having been taken from American publications. As a ready means of combatting scale on trees, especially those of the Citrus family, large deciduous trees being much more difficult of

treatment by the gas-tents, the cyanide treatment has much to recommend it, the principal objection, according to the best up to date American experts being the cost.

Having written to my good friend Mr. C. P. Lounsbury, Chief Entomologist in the Agricultural Department, at the Cape of Good Hope, asking for some notes on his experience *re* the cyanide treatment, this gentleman has kindly sent the following, which will be of interest to all concerned in the fruit-growing industry in Victoria:—

Orchard Fumigation.

The work, begun two years ago in furthering the fumigation method for the destruction of scale insects on orchard trees, has been vigorously prosecuted at every opportunity throughout the period covered by this report. In districts where the growing of citrus fruits ranks as a commercial industry, the endeavour has been to get the local fruit growers' association to operate a fumigation outfit or to have a few growers unite privately for this purpose. On the conditions that these co-operative fumigation clubs consist of not less than five members, representing at least 1,000 trees requiring treatment, that this number of trees be fumigated within ten months, and that the facilities be extended to non-members on reasonable terms, the Government has made each a grant of £25 towards the purchase of the initial outfit. Where co-operation has seemed impracticable, private parties have been urged and encouraged to procure small outfits for the independent treatment of their orchards.

There are now nine co-operative clubs with outfits at work, and of these, eight started operations during 1898. In the sequence in which they commenced, these are: Trappes Valley (Bathurst), Paarl, Oudtshoorn, Stellenbosch, Cathcart, Kei Road (King William's Town), Ncera (East London), Graaff-Reinet, and Van Staadens (Uitenhage). The covers and most of the other special apparatus required for these co-operative outfits, and for fifteen private outfits, were made to order, under my direction, and supplied to the respective parties practically ready for use ; this step was of great assistance to all, and, without the promise of it, the attempt to form most of the clubs would have been a vain task. A few private parties have bought cloth and made covers for themselves, as directed in letters to them, and it has been

learned that some have made covers from the instructions published in my *Gas Treatment* pamphlet. Most of the fumigators depend on the Department of Agriculture for their supplies of cyanide, this being sold to them at its cost to the Government. Parties, resident in the South African Republic, the Orange Free State, Natal, and Rhodesia, and such outlying parts of the colony as Namaqualand, and the Transkei, have written to get full particulars regarding the treatment, and in a few instances have availed themselves of the information given them, and the offer of assistance in getting the covers made. Mention of a large outfit made up for the Natal Government is made elsewhere.

Management of Outfits.

The arrangements for the management of the different co-operative outfits vary widely, a circumstance for which this office is in a large part responsible, for it was considered desirable to ascertain by experiment which of the various plans that suggest themselves prove best in practice. At Paarl and Stellenbosch, the outfits are owned by the local fruit-growers' associations, and are in charge of managers with whom it is stipulated that orchards be properly treated at a fixed tariff, and that a fraction—one-third or one-fourth —of the gross proceeds be given to the association, the remainder being retained as remuneration and to pay for chemicals and labour; the charges to the general public are slightly more than to members of the association. The Kei Road, Ncera, and Van Staadens outfits are owned by small clubs, the members of which subscribed the initial costs, and, in return, have free use of the apparatus. Outsiders pay 6d. a tree treated for the hire of the outfit, and both members and non-members pay the cost of the chemicals used and for the services of the manager. The members of the Cathcart Club contribute 1s. for each tree they desire to treat, to cover outfit expenses, and pay for the chemicals at cost. They altogether dispense with management expenses, each farmer attending to the treatment of his own trees after receiving instruction in the use of the apparatus from the honorary secretary of the club, a medical practitioner. This plan has, thus far, been the least satisfactory of the several described, a paid manager seemingly being a necessity. The Trappes Valley people raised the initial fund by a subscription list. They pay a manager £12 a

month, and treat trees at a charge which covers the cost, and allows for a renewal of the outfit. The subscribers had the first use of the apparatus, but have had no other advantage over outsiders.

Oudtshoorn has the most business-like arrangement. The whole fumigation plant is the property of the Fruit-growers' Association, and was paid for by the membership fees. Members' trees only are treated, but residents of the district may easily become members. The trees are treated at tariff rates, and, while these are high, there is no cause for complaint, since any surplus over expenses is association property. The manager is paid £12 a month, and is allowed a saddle-horse.

All of the clubs depend upon the farmers for the transport of the apparatus to or from their orchards. The Oudtshoorn Association owns a special waggon, but, with this exception, the clubs depend on the farmers for both vehicle and draught animals. Except at Oudtshoorn, dependence is also placed on the farmers for two or more boys to help with the work, and in several cases they are required to board and lodge the manager without charge.

Cloth for Fumigation Covers.

The covers for the early outfits were made of eight or ten ounce American cotton duck, of the best quality, and were lightly coated with a mixture of one part turpentine to four of linseed oil. Sometimes raw oil was used, and sometimes boiled; there appeared to be no great difference in result, but if more covers were to be oiled, preference would be given to the boiled. Raw oil without turpentine was applied to a number of covers; exposure to the sun for several weeks was required to dry these, and then the cloth was found to be not only stiff but very weak, slow combustion apparently having taken place. The oiling of the covers increased their weight by two-thirds, without, of course, adding anything to the strength, besides it invariably stiffened the fabric to some extent, thus making it less easy to handle, and more likely to tear. These objections to oiling the cloth might not be serious if the covers were always to be used on well-grown trees, and by experienced hands; but they proved decidedly serious where the covers were employed in treating misshapen, long neglected trees by parties with little or no previous experience. Our need was soon clearly seen to be

covers combining the maximum of strength and pliability with the minimum of weight. The necessity led me to experiment with unoiled covers of heavier cloth, and after several weights were tried, what is known as No. 10 American duck was adopted for large covers, and No. 8 for small ones. For several months, however, the lighter cloth, No. 10, has been used for both large and small sizes. Different brands of this cloth are sold, but only the most closely woven ones are adapted to our purpose. It weighs between 15 and 16 ounces to the square yard, and after it is well shrunk with water, no interstices should be apparent when it is held between the eye and the sun. The sewing is done by machine with Singer Company's linen thread, single seam for tent covers, and double for sheets; a short stitch is advisable, and No. 45 or heavier thread should be used for the sheets. It was found difficult to manipulate sheet covers of oiled cloth 50ft. in diameter, but even new hands have had no trouble in managing 57-foot sheets of No. 10 duck unoiled. In only one respect are the oiled covers superior to the stronger and more durable unoiled ones, and that is with respect to their gas-retaining properties. The gas escapes through even the oiled cloth, but much more rapidly through the unoiled, even though the latter appears equally tight to the eye. Despite of this defect, however, covers of the unoiled heavy cloth have given far greater satisfaction, and will probably continue to be used. But observation of the results obtained by use of the customary dose of one ounce of cyanide to 300 cubic feet of enclosed space (for red scale) has convinced me that allowance must be made for the loss of gas by diffusion through the covers. It is observed that the proportion mentioned cannot be relied on to destroy all the scale on small trees, when the unoiled covers are employed. A larger dose is advisable even under heavily-oiled covers, while, for use with the unoiled, I am of opinion that the proportion should be gradually increased from one ounce to 300 cubic feet for a tree 16 feet in height to one ounce to 125 cubic feet for a tree 6 feet in height. The surface through which the gas escapes increases in proportion to the space enclosed as the dimensions of the tree decrease, hence the necessity for giving small trees proportionately greater doses. There is more than four times as much surface to the space encompassed by the cover, in the case of a 4 x 3 feet tree, than there is in one 16 x 12 feet. When trees are dosed with the quantities of

chemicals recommended in the old tables, there is little odour of the gas, under the two smaller sizes of tent-form covers, 40 minutes after the reaction has taken place, while under the large sheets it is often disagreeably strong 90 minutes after, thus clearly demonstrating the error of basing the table of quantities on the cubic contents alone. A number of covers of a Willesden rot-proof and water-repellent duck, of the same weight and quality as the ordinary No. 10 duck, have been tested, and have been found to better retard the permeation of the gas, though not to a very marked extent. The cloth was less easily sewed than ordinary duck, and its odour of ammonia, when handled in the making, gave much annoyance to the parties who sewed it. The naturally green colour faded quickly under the action of the cyanide fumes. It is yet too early to decide definitely whether or not it is preferable to the ordinary cloth in the long run. The cost in London was about equal to what is paid for the other in Cape Town. Several parties are using covers of oiled unbleached calico, and express themselves well satisfied. Dressing a cover with fat, as waggon-sails are waterproofed, was tried by the manager of the Oudtshoorn outfit, and found inadvisable; the dressing never dried, and soon weighted the cover with an accumulation of adhering soil and rubbish.

Manipulation of Sheet Covers.

The style of uprights for raising and lowering the sheet covers described in the "Gas Treatment" pamphlet is still employed, but the long poles are now tapered from 2½in. x 4in. at the base to 1½in. x 4in. at the top, and are 26 feet in length, and the braces are cut 6 feet instead of 5; a simpler device finds a few champions among orchardists working with a single sheet. The idea is to gather half of the sheet in loops of rope, and by means of poles as levers to raise this gathered half until it is directly above the tree to be covered, while the loose half hangs to the ground; then to slacken the loops and thus permit the suspended folds to open and fall forward. Two long light poles pointed at the base, and at least 3 feet higher than the tallest tree to be covered, two pulley blocks, and a quantity of rope is all the apparatus required. Two small holes about the width of the trees apart, and in line with and equally distant from the centre, are cut in the sheet; the tops of the poles are passed a few inches through the

holes and are bound securely in this position, one end of a long rope is then fastened to the projecting top of the pole, and the other passed out around the margin of the sheet back to the pole beneath the hole, and through a pulley block there secured. When these tackle ropes are adjusted to both poles, half of the sheet lies in two loops, and hauling on the free ends of both ropes contracts the loops and thus draws the half of the sheet into folds. One or two guy ropes are attached to the tops of the poles to assist in raising and lowering them. Preparatory to covering a tree, the sheet is spread out and the half of it towards the tree gathered into folds as described; the poles are laid parallel one at each side, with the feet in line with the trunk and braced in some manner to prevent their slipping. Four men are required to raise the cover, two for each side; one lifts the pole while the other with a guy rope assists him and works to prevent the pole slipping to one side. To relieve the strain on the cloth it is customary to connect the tops of the poles with a rope a few inches shorter than the width of cloth between them. When the cover is in a position over the tree, the poles are of course beneath. This manner of manipulating the cover was first practised by Mr. W. E. Murray, of the Graaff-Reinet district, and by him explained to me. I found him covering trees fully 18 feet high, using dried flower stalks of American aloe (Agave americana) as his poles.

Generating Dishes.

China pudding-basins are now substituted for the lead dishes first used as generating vessels. They are much less costly, and are preferable on the score of lightness; also the smooth and rounded bottom inside is in their favour, it tending to keep the cyanide floating in the acid during the reaction, and thus rendering its complete decomposition most probable. The bottoms of lead dishes soon become battered and flattened; under this condition, lumps of cyanide may become stranded when the acid is shallow, and the dissolution thereby checked.

Extent of Orchard Fumigation.

The aggregate number of orchard trees treated during the year by the fumigation process is known to be above 24,000, and may be as high as 27,000. This is a large number for the Cape when it is considered how small,

scattered, and of uneven growth our orchards are, and that the treatment is in its infancy with us. The Trappes Valley Club reports that it fumigated 8,678 trees in fifteen months in 22 orchards; and the Oudtshoorn Club, 4,127 in 110 orchards in ten months. Satisfaction is everywhere expressed with the results, and some of the unsolicited statements as to the success of the treatment are more flattering than patent medicine testimonials; the fear that the scale would soon render the growing of citrus fruits unprofitable has passed away.

Fumigation of Deciduous Trees.

The employment of fumigation to destroy scale insects on deciduous trees has not been specially recommended, since these trees may be sprayed thoroughly during the winter with efficacious washes at a relatively lower cost. But fumigation may sometimes be advantageously substituted for spraying in the case of deciduous trees. If the treatment is performed during the winter, it may be carried on during cool days, under darkened covers, without injury to the trees, and doses strong enough to destroy all stages of even egg-laying species safely administered.

Nursery Fumigation Chambers.

The example set by the curator of the Grahamstown gardens, and by Mr. Henry Meyers, of the Fernwood nurseries, Newlands, in providing facilities for the fumigation of nursery stock—to which allusion with illustrations was made in last year's report—has been followed by Mr. H. E. V. Pickstone, of Groot Drakenstein, Messrs. Gowie Brothers, of Grahamstown, and by the curator of the Graaff-Reinet gardens. The two latter nurserymen have erected brick vaults very similar to the one at the Grahamstown gardens. Other nurserymen have promised to have chambers ready for use at the commencement of the selling season. All our nurserymen should be provided with fumigation chambers not only for the treatment of stock being despatched to their customers, but that they may insure the destruction of any scale insects which might infest stock received by themselves, either from abroad or from other South African nurseries, and also for the disinfection of scions and cuttings. If root cuttings of apple were fumigated before being grafted upon, many of our nurserymen would be spared much of the annoyance caused them by the woolly aphis.

Experiments to Ascertain Amount of Cyanide Required.

There is room for considerable investigation in ascertaining the amount of cyanide to a given space necessary to generate sufficient gas to destroy different insects exposed in an airtight chamber, such as a nurseryman would use, and if an opportunity presents itself, a little work along the suggested line will be conducted during the present year. A few experiments performed last year brought out some interesting facts. In an approximately airtight closet, the gas from one ounce of cyanide to 750 cubic feet in two hours failed to appreciably affect adult scale insects, but destroyed fully ninety-five per cent. of woolly aphis on stems of apple. One ounce to 450 cubic feet for one hour appeared to be fatal to the red scale in all stages, and to all but the eggs of the Oleander scale (Aspidiotus nerii), white Peach scale (Diaspis amygdali) and greedy scale (Aspidiotus camelliæ). The same strength for two hours did little more. One ounce to 300 cubic feet for one hour proved fatal to all stages of the species named and to the eggs of an oleander-infesting mealy bug (*Dactylopius sp.*), but a few of the adult mealy bugs survived an hour's exposure in one ounce to 200. When any of the species used in the experiments was much massed on the infested surface, the destruction was strikingly less thorough than when the scales occurred singly. A few adult females of the greedy scale in a mass of their kind, on the fruit of a large-fruited Solanum (Solanum aculeastrum), failed to succumb when exposed for an hour in one ounce to 300, while not one among many hundreds of scattered individuals lived through an hour of one ounce to 450. Similarly, some larvæ of the oleander scale sheltered in the scurf of old scales of its species on American Aloe (Agave Americana) survived one in 300. These observations confirm what has been suspected with respect to orchard fumigation, that a dose fatal to every scale insect, on moderately infested trees, sometimes proves insufficent in a very badly infested case by an occasional scale escaping through the protection afforded by a covering of other scales. A diligent search shortly after the treatment has often failed to reveal the presence of a single survivor among thousands of dead scales, but that a few had escaped the general destruction would become apparent after the lapse of three or four months. The decreased potency of the gas, as it penetrates masses, was prettily illustrated by its action on the eggs

of the Australian bug (*Icerya purchasi*). This scale insect, be it remembered, deposits a very large number of eggs in a sac-like outgrowth from the posterior of its body, and the eggs within this ovisac are embedded in a mass of protective cotton-like filaments. Comparatively weak gas destroyed the eggs nearest the end of the sac, but had no effect on those further within. As the doses were increased in successive tests, larger and larger proportions of the total number succumbed, but those in the layer immediately against the body survived even one ounce of cyanide to 200 cubic feet, and a very few in the largest sacs withstood even a half-hour's exposure of one ounce to 150 cubic feet. A number of young apple trees badly infested with woolly aphis were exposed to the gas, after soaking the roots in water to remove the soil. One ounce to 450 cubic feet for one hour appeared at the time to be thoroughly efficacious, but, after the lapse of three months the roots of even those exposed to one to 300 for an hour, and of those to one to 200 for a half-hour, were again much infested. The film of water about the roots or the traces of soil still clinging to them had evidently served to protect a number of the insects. Altogether the series of tests, though incomplete, indicates that, in the disinfection of nursery stock, care should be taken to give the gas free play among the trees, and that it is advisable to employ much stronger doses than what are known to be fatal under ordinary circumstances. Dormant deciduous stock is not injured by exposure to four times the normal orchard proportion for citrus trees—one ounce to 300 cubic feet. The cost of charging a small chamber is a mere trifle, and, this being the case, my present recommendation to nurserymen is to use not less than one ounce to 125 cubic feet of space when treating deciduous trees. The strength which citrus trees will stand without being injured has not been determined, but fully dormant stocks are not injured in the least by one ounce to 250, nor more than the tips of growing trees by one ounce to 300; under favorable conditions at least, the latter proportion is fatal to all stages of the scale insects known to affect citrus stock in the nurseries of this colony, with the exception of the Australian bug and mealy-bug.

Hydrocyanic Acid Gas for Glass-house Fumigation.

An officer of the United States Department of Agriculture has been experimenting off and on for the last four

years with hydrocyanic acid gas as an insecticide for the destruction of various kinds of insect pests which affect plants in glass-houses, and, following his lead, a number of gardeners have adopted this fumigant. It is said that it has been found possible to destroy practically every insect without injuring so much as a leaf or flower. Even mealy-bugs and *Orthezia insignis* are said to be destroyed without the least injury to so delicate a plant as Coleus. A description of the process, taken from an American source, was published in the *Gardeners' Chronicle* for 16th July, 1898, and from this I glean the following particulars :—Three parts of acid to two of boiling water are used, and the cyanide added while the acid water mixture is bubbling with heat ; this secures a very rapid evolution of the gas, and necessitates the use of a large generationvessel to prevent slopping over the sides. The exposure is a short one, the house being opened as much as possible from outside as soon as 25 minutes have expired. For each cubic foot of free space enclosed, one and eight-tenth grains of cyanide are used ; which, if troy grains are intended, as seems most probable, is equivalent to one avoirdupois ounce to 200 cubic feet. "All damp must be driven out of the house, and the plants should be quite dry in their foliage before commencing to fumigate them with the cyanide, because if there is any moisture on the leaves and young growths, they are liable to get scorched. All being dry and in good order, the process may be carried out with perfect safety to the plants ; and houses full of palms, ferns, roses, violets, carnations, and other tender plants and flowers, have been treated as described with the most successful results, the insects being destroyed, and neither a flower nor a leaf hurt in the least."

To what extent this innovation in glass-house fumigation has come into practice I do not know, but its discussion in several gardeners' papers has attracted wide attention to it. Opinion concerning its practical value is diverse, largely on account of the risk of both to the operators and the plants, but there seems to be no question that, when certain precautions are fully observed, the results will be all that is claimed above. However, I do not refer to the use of the gas in glass-houses here, in order to recommend its general adoption in this country. I am not prepared to do that, not having experimented to satisfy myself just what precautions are necessary to insure entire safety to the plants. But I do suggest that nurserymen and florists who have fumigation

chambers, and gardeners who have closets or rooms they could safely use as chambers, should experiment on pest-ridden plants to which they can afford to risk injury, and demonstrate to their own satisfaction the economy of the process. The essential feature to prevent injury to the plants, seems to be the absence of moisture, both in the air and on the foliage. Our climate is so mild a one that it is unnecessary to have glass-houses here built and kept in such good repair that they are approximately gas-tight; and it naturally follows that the proportion of them which may be closed tight enough to answer as fumigating chambers is not large. Further, owing to the exceedingly poisonous character of the gas, its use in conservatories attached to dwellings is dangerous. For these two reasons, it is unlikely that the gas will become a popular glass-house fumigant in this colony. Still, florists, curators of public gardens, and gardeners on large estates, may find its use, particularly in special chambers, a welcome improvement on their present methods of dealing with scale insects and aphides on house plants.

Hydrocyanic Acid Gas for Dwelling Fumigation.

I mention the subject principally to condemn this dangerous practice. It has been suggested, not unnaturally, by the highly-successful results obtained in destroying orchard pests by the gas. Almost needless to state, the chief intent of house fumigation is to effect the destruction of that unmentionable, but in this colony by no means uncommon, insect which is recognised in scientific circles by the appellation *Acanthia lectularia*. The gas, when used at double the strength for orchard treatment, does have a most beneficent effect on the creatures, but it does not often accomplish a complete riddance. The construction of most colonial houses is too faulty for thorough work, currents of air entering crevices and diluting the gas in them to a degree at which it is not deadly; by virtue of this, a few of the vermin or their eggs are tided through the deadly visitation to their mates. Extermination being improbable, there is little to induce one to give this remedy preference over less dangerous measures, and I think that parties other than experts, who know just what risks are assumed and what to do in case of an accident, are wholly unwarranted in employing it. Even experienced hands had best avoid its use under ordinary circumstances. Hydrocyanic acid gas is not

a poison to trifle with, and as a warning to those whose enthusiasm over its unrivalled insecticidal properties leads them to meditate its use in their dwellings, I invite their consideration to the fact that I have learned of several instances, within the last year, of parties having narrowly escaped death when such use was being made of it. The danger is not in the generation of the gas, but in the subsequent opening of the rooms for ventilation, and in the risk of parties entering the rooms unawares during the operations or too early after they are over. The danger attached to orchard fumigation, or the use of the gas in special chambers, is infinitesimal in comparison. In connexion with these uses of the gas I have not heard of a single accident occurring in this country, and only one, a temporary prostration due to deliberate disobedience, in America.

In Victoria but little has been done in the way of the cyanide system of fumigation, although at the Burnley Gardens a complete plant is working. This is only for trees and plants which are imported from the neighbouring colonies or from outside. The Burnley fumigator is a wooden building lined with felt and then papered, the cyanide being introduced, for safety's sake, from the outside of the building, so that there is no danger to be apprehended from suffocation from the effects of inhaling the gas during fumigating operations. Near the floor of the room is a "turbine fan," this being worked by water, so that, when the time of enclosure has expired, the cap of the tall flue is opened by means of a lever, the water turned on, and the building in the course a few minutes may be opened with safety, and the trees removed to make room for another lot which require similar treatment.

Every nursery in the colony which sends out trees for sale should, in my opinion, be compelled to have a small fumigator erected on the place, so that all stock to be packed should be first treated by means of the cyanide chamber. It need hardly be pointed out to any practical man that it is from nursery stock, far more than from fruit, that the great danger of introducing many diseases lies; as with fruit the chances of escape from infection are many, but with trees you plant your orchard and at once establish the disease, be it fungous or insect, on a permanent basis. With regard to the fumigation of fruits imported into Victoria, I must admit that I am against such a course, for the reason that growers

who send their fruits here should be compelled by law to send it free from disease or not at all. I hold it to be unfair to our own growers, who are compelled by the terms of our Vegetable Diseases Act to keep their orchards clean and free from disease; while to erect fumigators would, in my opinion, tend to render our colony a "dumping ground" for diseased fruits of other countries.

It has been proved beyond all doubt, in the case of oranges and lemons which are exported to Victoria from Messina and other places in Europe, that by rejecting all diseased and scale-infested fruit, we are only doing justice to our own growers, as each year, owing to careful supervision on the part of our inspectors, the fruit so imported is showing a marked improvement, whereas were fumigation at our port permitted, we should have the same tale to tell of dirty, foreign fruit being sent here as before. In closing these few remarks *in re* the fumigating of trees and fruit by the cyanide process, it may be mentioned, on the authority of our vegetable pathologist, also upon the testimony of other gentlemen whose opinions cannot be doubted, that the fumigation of trees by the above-mentioned process, has no effect upon diseases of fungous origin. In Victoria we have had but little experience with the cyanide treatment as practised under canvas, but as all the information regarding the gas-tents, &c., is well understood, and as the tents can be made here, there would be little or no difficulty in the way of a commencement being made on the co-operative system as practised in America and elsewhere.

FRUIT FLIES.

WEST AUSTRALIAN FRUIT FLY.

(*Halterophora capitata.*)

Fig. 1. Fly. Natural size. (From nature.)
,, 2. ,, Magnified. ,,
,, 3. Larva. Natural size. ,,
,, 4. ,, Magnified. ,,
,, 5. Pupa. Natural size. ,,
,, 6. ,, Magnified. ,,

QUEENSLAND FRUIT FLY.

(*Tephritis Tryoni.*)

Fig. 7. Fly. Natural size. (From nature.)
,, 8. ,, Magnified. ,,
,, 9. Larva. Natural size. ,,
,, 10. ,, Magnified. ,,
,, 11. Pupa. Natural size. ,,
,, 12. ,, Magnified. ,,
,, 13. Peach infested with larvæ. ,,

Fig. 14. Fruit fly from New Hebrides. Natural size. (From nature.)
,, 15. Magnified. (From nature.)

C. C. Lee Lithograph Del. C. French Direxit.

FRUIT FLIES.

(By C. French, Government Entomologist.)

I.—THE WEST AUSTRALIAN FRUIT FLY.

In the early part of the present year, my attention was directed to some maggots in a consignment of peaches which had been sent from Sydney for sale in Victoria, and having placed the diseased fruit in an anatomical jar, our worst fears were soon realized, and in a few days two specimens of the so-called West Australian fruit fly (*Halterophora capitata*) made their appearance. It is most unfortunate for growers here that this much-dreaded pest should have been added to the numerous troublesome insects with which the fruit-grower has to contend.

In this pamphlet it is not intended to give a full account of these destructive little insects, as this will be done in Part IV. of the "Handbook of Destructive Insects of Victoria," shortly to be issued, still it was thought necessary to bring some facts and short descriptions before the public, so that these pests might be recognised when seen. Fortunately for us, the so-called Sydney and Queensland fruit fly has not, as far as we are aware, yet made its appearance in our colony, but as it is almost certain to come, we had better be prepared for it.

In New South Wales and Queensland both of these pests are present, and do immense damage to fruit of many kinds, so that the title of peach fly is hardly applicable to an insect which will tackle, as the fruit fly is said by Mr. Tryon and others to do, not only peaches, but apples, pears, quinces, nectarines, plums, oranges, shaddocks, and even figs, thereby rendering these fruits as near as possible unfit for human consumption.

In describing these flies, we cannot do better than give roughly the descriptions as mentioned by Messrs. Tryon, Fuller, and Froggatt, and these, with the assistance of the plate which accompanies this pamphlet, will, we trust, be sufficient for the present purpose, or at least until such time as Part III. appears, in which a coloured plate containing both insects will be given.

Life History of H. capitata.

The eggs, as described by Mr. Fuller, are laid in the fruit by the female fly, and the larvæ soon hatch from them and commence feeding. When they are full grown, the maggots leave the fruit and enter the soil to pupate, that is to change into the last stage prior to their emergency as perfect insects, and great numbers are carried to the ground in the falling fruit. After having rested in the soil as pupæ for about twelve days, the flies hatch and make their way to the surface and continue their destructive work.

In Western Australia, Mr. Fuller remarks that the fruit is attacked just as it begins to sweeten, and before it ripens. Green fruit being seldom if ever attacked. The eggs are laid in the fruit by means of a very sharp needle-like organ (see figures on plate), called the ovipositor, borne on the extremity of the abdomen of the female. The maggots are soft, yellowish-white in colour, somewhat shining and limbless worms, and somewhat resemble those of the meat fly. The pupæ or chrysalids are oval and stout, at first a golden yellow colour, but subsequently changing to a reddish-brown. The flies are pretty little insects, with two wings only, about half the size of the common house fly. They have very large and lustrous eyes, the thorax is mottled with grey and black, and the abdomen is of a brownish-yellow and crossed by two stripes of a silver-grey colour. The wings are large and ample; they are transparent, strongly veined, and marked by several clouded bands of grey and yellow colour. The legs are long and slender and of a yellow colour. In walking, the fly always carries its wings in a drooping attitude. It is a very difficult thing to find the flies in an infested orchard, although they must be present in large numbers. If, however, a maggoty peach is put aside in a box for a few weeks, the flies can be reared and easily observed.

Remedies.

It has been remarked by those who have had most to do with this pest, that the measures adopted must be more of a preventative than a curative kind. More insidious than the codlin moth, the trouble is at all times internal. Two of the most efficacious means of checking the codlin moth, viz., poisoning by means of paris green, and trapping the chrysalids, are of no avail when dealing with the fruit fly. The means recommended by those who have had much experience with both these insects, are—

(1) Pick and destroy affected fruit and remember that the full-grown maggots are in the ripe fruit, and although many of them fall to the ground of their own account, most of them leave the fallen fruit some time after it has been laying on the ground. The crop on the first trees affected should be sacrificed in order to save the bulk of the fruit that ripens later in the season. The period of incubation of the egg is very short, and the fly only punctures the fruit a fortnight or so before it ripens, so that if the trees are carefully examined at the time the fruit is fit to pick, it will be seen whether the grubs are present or not.

(2) All fruit showing evidences of the presence of maggots, and also all fallen fruit should be gathered daily and destroyed. Boiling is the best process, although feeding to pigs is the one

generally adopted. The latter plan has, however, many disadvantages, because often the pigs cannot eat all the fruit, and, moreover, it is not impossible for the maggots to pupate in the stye.

(3) Poultry—as fowls, ducks, and turkeys—should be allowed to feed under the infested trees.

(4) A layer of gas lime, one inch thick, should be spread under greatly infested fruit-trees, and, when the fruit is all off, gas lime might be dug in, and so utilized as a manure. The lime acts in a caustic manner and destroys the maggot by contact. As to how this pest has been introduced into Western Australia is a mystery.

II.—THE FRUIT FLY OF NEW SOUTH WALES AND QUEENSLAND.

This formidable enemy of the fruit-grower has been named by Mr. Froggatt after Mr. H. Tryon, Government Entomologist of Queensland, who has unfortunately had but too many opportunities of dealing with and observing this pest.

Life History.

The eggs of this species, as Mr. Tryon remarks, are just large enough to be seen upon a dark background by the naked eye. The full-grown maggot is about four-tenths of an inch in length.

A feature of the maggot, not generally known, is that it is an air-breather, and that, if air be excluded from the fruit, its inhabitants must die. The chrysalis is one-fifth of an inch in length, and exists in a partly comatose condition till it develops into the fly.

The fly is brown in colour, with two clear opal-tinted wings, conspicuously bright, light-yellow spots on the body, and bright blue eyes. The male is easily distinguished from the female, as the posterior portion of its body is rounded, while that of the female carries the ovipositor and pointed projectile used to pierce the skin of the fruit and deposit the egg in the tissue. The ovipositor can place an egg one-twentieth of an inch below the surface. The fly's length is three-tenths of an inch, and its wing expansion four-tenths of an inch. When disturbed, it does not fly far, but tries to hide beneath the leaves, and for this reason often goes unobserved.

Mr. Tryon concludes that the average life of the insect is about five weeks, and that each female lays about a dozen eggs.

The fly is fond of syrups, but will not touch any that are at all fermented, and it has a convenient habit of vomiting any food it finds distasteful or disagreeable.

When fruit is easily punctured, the fly distributes its eggs through many, but occasionally eight, and even the whole batch are placed in one fruit. It is not usual to find eggs laid in fruit before it is two-thirds grown, as the female seems to defer operating till a pleasant odour from the fruit is perceptible.

Regarding the periods of development at which the fruit is attacked, Mr. Tryon, together with Mr. Searle, furnish some valuable information. The eggs take three days to hatch when under observation, but in the open they will be hastened or retarded by climatic conditions. Occasionally the young grubs are killed because the growing fruit presses upon them, and in other cases the young are unable to break down the tough woody tissue of immature fruit. Mellow saccharine fruits hatch out all the eggs, and the grubs mature unless the tunnel becomes close and excludes the air. In pip fruit and slipstone peaches the grubs can live near the centre, but in close-stoned fruit they must work near the surface. The life of the grub in the fruit is from two to five weeks, occasionally less than two weeks. It invariably happens that, when the grub has done feeding, it leaves the fruit, which has then usually fallen to the ground. After leaving the fruit the grub usually tries to hide beneath the soil, sometimes going as deep as 4 inches, and then within 24 hours changes into a chrysalis. In summer a period of from seven to fourteen days elapses before the fly emerges out of the chrysalis, but in winter the lethargic condition continues much longer. There are several broods during the year, and from August to April (in Queensland and New South Wales) reproduction is virtually continuous, as females preponderate, and as each lays twelve eggs prodigious multiplication is the result.

Occasionally the fly passes the winter as a perfect insect; the ability to breed throughout the year is due to the succession of fruits, from loquats to oranges in winter.

Remedies.

The remedies as mentioned by Mr. Tryon I am inclined mostly to agree with, and amongst other materials mentioned is the prepentive stage, that is to protect uninjured fruit from attack. At present millions of flies are being bred in the infected fruit that is allowed to rot beneath the trees. There is also the advantage of fine netting with which to cover the trees, but this in large orchards would of course be too expensive to most people. The flies can no doubt be kept away also by offensive odours of different kinds, as kerosene, preparations of tar, &c., but this latter could only be done some weeks before the fruit ripened. Mr. Tryon also recommends that wood tar, if smeared on pieces of rag or tow and hung suspended in the trees, be adopted, and I have

no doubt whatever as to the value of this recommendation. The Italians have mixed wood tar with soda crystals, making a perfect solution for spraying; a system which Mr. Tryon informs us has but lately been published. The shelly covering of the chrysalis renders it practically impervious to any liquid applications, but if the ground is dug up or raked, so that the chrysalis is exposed, it dries up and dies. When the fruit drops to the ground, the pest is virtually caught in its own trap. Then is the orchardist's opportunity. If the infested fruit is gathered at least daily and destroyed, the development of another batch of flies is prevented. Burning or scalding would be most effective, but, as this is not always a convenient method, it would be found well to keep an open trench about 2 feet deep in which the fruit should be buried, and the covering of the earth rammed down. Another effective way would be, as Mr. Tryon thinks, to place beneath the trees some caustic substance which will destroy the tender maggot, and he has found ordinary gas lime most efficacious. Several persons having tried this and found it both inexpensive and effective, as its deterrent odours drive the flies away. Dr. Cobb, who has had many opportunites of dealing with the pest in New South Wales, is not enamoured of the system as above recommended, and counsels constant cultivation, so as to destroy the grubs and pupæ below ground. In Malta we are informed that this West Australian fly does great damage to the orange crops, and, according to the Rev. Mr. Henslow, its attacks appear to be confined to oranges only. Finally then, the only effectual plan is to carefully examine the growing fruit, also any which may be sent from the other colonies to Melbourne markets, and in the case of growing fruit, the trees should be examined as often as possible, especially near the time of the fruit changing colour for ripening. Upon examining ripe fruit, peaches especially, very close observance will be necessary, as the indications to an untrained eye are difficult of detection. Should any outward signs present themselves, either as punctures or premature decay, cut some of the fruit in halves, and, if the maggots be present, the damage will soon be disclosed.

A valuable addition to the economic literature on these two flies has been written by Mr. Froggatt, whose excellent plate will greatly assist growers who have never previously seen these insects in their various changes. Before closing, it may be of interest to note that specimens of a fruit fly, closely allied to the two species with which we have been dealing, but nearly three times as large, have been sent to me from the New Hebrides, where, owing to the attacks of this fly, the orange crop has suffered badly, and this, in case of its possible introduction into Victoria, we have also figured; only the perfect insects being

available at present. We trust this pest may not come this way, although it being a larger insect, the indications of its presence are likely to be more pronounced. If the presence of any of these flies is suspected, it should be reported at once, and all growers and dealers, no matter how small, would do well to act in concert, as, when these pests make their appearance, there is no saying how far they will spread, or how extensive the damage they may cause to the fruit industry of our colony.

It may be mentioned that the Queensland and West Australian fruit flies have been proclaimed as noxious insects under the Victorian Vegetation Diseases Act.

Since the publication of the notes on these pests, the larvæ have been found, on inspection by us, in tomatoes, mangoes, and persimmons, so it appears that there are but few soft fruits which it will not attack; and in Part IV. will be some fine coloured illustrations of this and the Mediterranean species, also a brief mention of one from the New Hebrides. Mr. Froggatt has recently described two more species, one of which attacks the guavas, and he has therefore named it *T. psidi*, the other, *T. muscæ*, having been found in bananas from the New Hebrides, but differing, according to Mr. Froggatt, in the markings, &c., from that figured with the notes here given. We much regret to learn that the West Australian Fruit Fly has made its appearance also in Tasmania. Since the publication of our pamphlet on the San Jose Scale the *Agricultural Gazette* of New South Wales has the following :—

"Some months ago a correspondent reported that, as a last hope, he had painted with kerosene direct from the tin some young trees badly infected with San Jose Scale. He had evidently got the idea of this treatment from an article which appeared in the *Agricultural Gazette* for May, 1898. When the paragraph about the success of his experiments appeared in the *Gazette* there was much comment, but according to Bulletin 138, New Jersey Agricultural Station, Professor J. B. Smith (whose article was printed in the *Gazette*, May, 1898) has during the past two years treated nearly 4,000 trees of all the orchard fruits, except cherries, with crude petroleum, either undiluted or mixed with from 60 to 75 per cent. of water.

"The trees operated upon varied from stock just out of the nursery row to old trees in full bearing.

"Not a single case of injury to any tree treated in winter has been observed; on the contrary, in a number of cases the oil seems to have acted as a stimulant, and the sprayed trees have

showed greater vigour and better foliage than those not treated. In no case has there been any injury to fruit buds, but on this point the observations are incomplete, no early winter treatment having been made in bearing orchards.

"Applications made after 15th January (midwinter) have in no way lessened the crop of apples and pears the year following, and applications made in March have not injured the fruit-buds in peach and plum (July and September here.) Crude petroleum is not suited for a summer application, either pure or diluted, because of its choking effect on foliage and its persistence. This, however, increases its value for winter work, as compared with kerosene. The latter acts at once or not at all, and evaporates very soon after it has been applied ; in fact, to avoid injury it must be applied in such a way as to favour rapid evaporation. Crude oil does not evaporate readily ; it is penetrating, and if applied with a brush half-way round a branch will often soak round the branch completely. It remains as an oily or greasy coating for many weeks, and no scales can set on this coating within a month of the application and live. It does ordinarily penetrate through even the surface layer of bark. Under the most unfavorable circumstances, if the outer layer is penetrated, the inner layer remains healthy and there is no progressive injury. It does not seem to interfere with bark functions, and young trees painted with the oil increased in size quite as rapidly and freely as those untreated. Crude petroleum will kill the San Jose Scale in winter, whenever it comes in sufficient contact with the insect. It is a contact insecticide, and will not injure what it does not touch ; but, liberally applied, it will soak through masses of scale no matter how densely set, as nothing else will. A minor advantage is the fact that it gives a greasy brown colour to the bark, making it easy to see exactly how thorough the application has been. . . . . ."

The same journal goes on to say that it is hardly likely that the indiscriminate use of either crude or refined petroleum will ever be recommended, but in a young orchard a little might be applied with a brush the moment a scale is discovered.

It may be mentioned, for the information of growers, that the early appearance of this scale, on apples especially, may be determined by a bright purplish rose-coloured blotch apparent on the rind of the fruit, which blotch increases in size, and at this stage the young scales are easily detected ; the affected fruit in such cases should be at once destroyed.

The Apple-bark Ring-borer. (*Prosops pedisequus*, Buckton.)

Some time ago my attention was directed to some apple and other trees which were rapidly being destroyed owing to some insect having perforated both the upper part of the stem and branches of the tree, the locality from which I received the information being in the Goulburn Valley district, situated about 15 miles from Numurkah. Upon receiving the information, I at once started for the purpose of ascertaining, if possible, some particulars of the insect doing the mischief, also to recommend some preventive and remedial measures as treatment for the same. I found on certain of the trees, fairly large apples, to have been perforated to a large extent over the stem and thicker branches of the tree. Amongst the branches certain small insects were found and captured, but I soon found out that I had not got hold of the real culprit. Having tendered some advice as to what was best to be done, I left for Melbourne.

In the month of January a well-known orchardist of Balwyn, about 7 miles from Melbourne, called upon me with portions of some of his trees which were badly affected and were rapidly dying out, and I at once recognised the fact that the same kind of pest was at work in both orchards. Upon visiting the orchard in question, the owner showed me an insect which he suspected of having caused the damage to the trees, and upon examination I found this to be an homopterous insect, whose habits would justify the conclusions arrived at by the owner of the orchard, and by the aid of Mr. Buckton's fine work on the *Tettigidæ*, recently published, I was able to place our insect in the group in which it has now been placed by Mr. Buckton. Having forwarded the specimens to that gentleman, he kindly named the specimen as above, both the genus and species being new to science. This insect deposits its eggs just below the outer bark of the tree, in long oval holes made by the female. The eggs are placed in rings around the trees, and the rows are often within a few inches of each other, the eggs being white, one in each hole, and have a porcelain-like appearance (a beautiful coloured plate of this insect will appear in Part IV. of the Handbook), the aperture, after the eggs have been deposited, being closed with a white flocculent substance.

Mr. Buckton remarks that other kinds belonging to this group (which, by the way, are not far removed from the Cicadæ), are known to ruin sugar-cane in parts of India and other tropical countries. It would appear that this is not by any means a new pest, as many of our old orchardists noticed the punctures on their trees years ago, but up to the time of my having visited the Balwyn orchard, the real cause had not been discovered. It has since been ascertained that the natural home of this pest is in the bark of the young gums (*Eucalypti*), so that its wide range can well be imagined. It is a truly pitiable sight to see a once splendid orchard, celebrated for its fine apples especially, nearly ruined by the depredations of such a comparatively small insect, which is less than half the size of our common house-fly, this being another of the too frequent examples of an indigenous insect having partly abandoned its natural food for the more palatable fruits of our orchards. I have counselled severe pruning when the tree is dormant, the prunings to be immediately burned, and, having done this, a thorough painting of the stem and larger branches with lime, sulphur, and soft-soap mixed; the smaller branches to be sprayed with kerosene emulsion or resin compound, put on the trees as hot as possible. So far, we have found no indication of this pest having attacked the roots, but as this group are, in certain stages, below ground, it may happen that the roots may also be attacked. I consider the pest to be one of the most formidable with which we have to deal, as, if badly attacked, the trees die out in a very short space of time; and should growers notice any trees affected in the manner previously described, no time should be lost in reporting same to this branch of the Department.

The Orange-tree Weevil (*Orthorhinus cylindrostris Fab.*)

This is an insect belonging to the great family of the Curculionidæ, commonly known as Weevils, and in Victoria, at any rate has only recently come into notice as a serious pest of the orchardist. This beetle is about half-an-inch in length, greyish-brown in colour, with a long rostrum or snout, the feet being prominently padded and appear, for the size of the insect, very prominent. The larvæ or grubs are of a yellowish-white colour, thick for their length, and whilst in the wood their bodies are in a curved position, the males being much smaller than the females.

The natural food of this beetle is in the wood of certain native trees, but of late years it has been found attacking citrus fruits, and in Queensland and New South Wales, other kinds of fruit trees also (a coloured plate with full description of this insect is now ready for Part IV.), so that we must keep a sharp look out for it in our orange groves and orchards. In Queensland, Mr. Tryon, speaking of an allied species (figured in Part III.), remarks "that there is reason to suppose that not less than twelve months elapse between the time when the egg of this beetle is deposited in the tree and the development of this into a full-grown beetle. These insects, though rarely met with in October, are about during the hottest months (Queensland) of the summer, and it is during the autumn and winter that the larvæ feed. It is owing to this fact, viz., that the destruction of the tree is being effected whilst the leaves are off, that their work cannot be noticed until the tree in which they have taken up their abode is beyond recovery." In our plate of Part III. a dark-coloured form of this insect is figured, the same having been found on an orange tree, near Melbourne. The first indication of the presence of this, or other borers in a citrus tree, is that the plant commences to turn yellow, and assumes a limp and sickly appearance ; and if upon examination the tree is found to be badly affected, the best plan is to grub it out and burn it on the spot, or as near to it as possible. It will be seen by our plate that the wood has been badly tunnelled, and the tree past the hope of permanent recovery. It is a singular fact, but one well known to collectors, that this beetle and its ally, the Apple-root Borer, are seldom to be found feeding or even crawling on the indigenous trees. It is true that one occasionally comes across a specimen or two, but in the orchard the Leptops at least may often be taken in large numbers, showing, in my opinion, that the native and natural food of the insects has been mostly abandoned by the insects under notice.

The Redgum-tree Weevil (*Strongylorhinus ochraceus*, Schaum).

It will have been frequently observed by persons accustomed to travelling, that many of the eucalypts (gum-trees) are disfigured on their stems by large excrescences which, at a distance, often have the apppearance of a swarm of bees settled upon the stem of the tree. This disfigurement has been traced to the depredations of the above-named insect,

and, in the Myrniong district, trees so attacked are of very common occurrence, the tree, in the course of a few years, dying from the effects of the boring to which it has been subjected. The eggs of this beetle are deposited, one at a time, in the hole made in the bark by the female insect, who bores into the bark with its snout, and, having completed this function, deposits one egg only in each hole, covering same with a sticky secretion. (Our plate for Part IV. shows the insects at work, also the egg and larva *in situ*, together with the parasites, which are several.) These insects, which are fairly common, are of a brick-red colour, the male, as in the rest of the group, being smaller than the female. We can only hope that this formidable pest may not develop a liking for our orchards, as in such a case the matter would be a serious one. It is fortunate for us that this insect has many enemies, the ichneumon flies having little difficulty in discovering the whereabouts of the grubs in the tree, and by means of their long ovipositors, which are capable of extension, are able to deposit their eggs in the larvæ of the beetle, thus destroying all chances of the beetle attaining maturity.

The Grey Apple-grub (*Pinara sp.*).

This formidable pest of the apple-grower, is a native of Victoria, and formerly had for its food the indigenous plants of the colony. The moth (as figured in Part IV.) is of a yellowish-drab colour, the eggs being deposited in clusters or patches on the leaves of the apple. The larva is a most singular-looking beast, lying flat on the branches, so that its presence, to any but a trained eye, is not easily detected. The pupæ is of a chestnut-brown colour, the male of the perfect insect being smaller than the female, each sex being remarkable for the snout-like appearance of the frontal portion of the head. The larvæ of these insects not only "roll" the leaves of the trees attacked, and in which the pupæ change, but eat the leaves as well, so that, where the grubs are at all numerous, the process of stripping a tree of its foliage is speedily accomplished. In the Somerville and other fruit-growing centres this pest is very troublesome; hand-picking and spraying with the arsenites being the best means yet adopted of ridding the orchards of these troublesome insects. As to the correct name of this insect there appears to be some uncertainty, but this matter will

be cleared up as soon as possible, the specimens, from which the illustrations have been taken, having been reared from the larvæ in the insect room attached to the office.

The Dark-green Grass Caterpillar (*Oncoptera intricata*, Walker.)

The larva of this moth is without a doubt the most destructive of all the grass-root feeding insects known to myself. The female moth is of a light-brown colour, mottled with darker markings, the male being smaller and more reddish in colour than the female, the former being about $1\frac{1}{4}$ inches across the wings. The eggs are deposited, it is supposed, upon the stems of grasses of many kinds, and the larvæ when sufficiently strong, descend into the soil, just below the surface, and at once commence to feed upon the roots thereof. The larva, when fully developed, is about $2\frac{1}{2}$ inches in length, sometimes longer, and is of a dark sap-green colour. When taken in the hand, the grubs are very lively, and have a strange habit of jerking back the head and forepart of the body. The larvæ are most voracious feeders, and in some of the best districts of Gippsland and elsewhere the damage done to the grass on grazing areas has been enormous, thousands of acres having been rendered absolutely bare of all herbage whether natural or introduced. On large grazing areas the task of eradicating this pest becomes almost a hopeless one, but in agricultural holdings, also in small places, a thorough and constant stirring of the soil would no doubt so injure the grubs that they would die before assuming the pupa stage. The bran and arsenic treatment would probably be effective in the case of these grubs, as it has proved in the treatment of cut-worms, &c. Take 50 lbs. of bran or middlings, 12 lbs. of arsenic, and 6 lbs. of treacle, mix the whole into a paste, and either place pieces here and there amongst the crop, or sow broadcast, as the case may be. The moths are easily attracted by a strong light, and fires made (should the grass not prove too dry) through the place will attract numbers of the moths, when they will be either destroyed or fatally damaged. In the plate which I have had prepared for Part IV., a fungus is shown which attacks the larvæ of this moth, and we can only hope that some such disease as that which has killed off the cut-worms in the Bacchus Marsh, Mallee districts, and elsewhere, may also attack these grubs.

Green Hanging Moth of the Apple (*Hepialus lignivorus*, Lewin).

A beautiful moth, the upper wings in the male of which are of a soft pea-green colour, with silvery-white markings, lower wings being very pale green. The female has the upper wings of a somewhat darker green, with purplish bands or markings across them, the lower wings being of a pale-rose colour. The male of this insect is about $1\frac{3}{4}$ inches across the wings, female being larger. The larva is of a pale-pink colour, with head of a dark brown, and furnished with strong mandibles or jaws. The pupa is pale yellowish white, and the plate shows the rudimentary wings and method of attack, all having been taken from nature. Hitherto this moth has confined itself to the native trees, as Melaleuca, &c., but of late it has been terribly destructive to apples especially; Mr. Grant, the well-known orchardist of Pakenham, Victoria, having reason to deplore the fact of it having now extended its attention to orchards. The eggs are deposited either upon the bark of the tree or in shallow crevices, and the young larvæ, when hatched, commence at once to eat their way into the heart of the tree, mostly in the branches. In many respects the larva of this pest resembles, in its methods of working, the well-known cherryborer, a plate of which latter insect is given in Part I. of our handbook. As the larvæ increase in size, the damage done is proportionate, until at last the tree is so tunnelled that the affected parts at once commence to die off. The presence of the grubs of this moth is easily detected by reason of an exterior swelling, this being simply an accumulation of a sawdust-like material enclosed in a delicate web, which latter I suspect is intended to form some protection to the grub inside the tree. When the perfect moth emerges from the pupa, it at once clings to a branch, and there remains in a hanging position until the wings become sufficiently hardened by exposure to enable the insect to take wing. The group *Hepialidæ*, to which this moth belongs, comprise some of the finest and, withal, some of the largest, of moths, *Leto Staceyi*, found in New South Wales, not infrequently measuring no less than 10 inches across the wings. The larvæ, being of large size, do an immense amount of damage to certain of the large eucalypti growing

in the Newcastle and adjacent districts. Belonging to an allied family, the *Zeuzeridæ*, are several very destructive moths, the large goat-moth of the wattle being one of them.

There are, of course, a large number of important insects, both destructive and beneficial, yet to be dealt with, the life histories of many of which have already been worked out; and the information so gained will be published in a form available alike to orchardists and others.

In conclusion, I have to express my gratitude to those who have assisted by forwarding to me the results of their field observations, also for the donation of many specimens, which latter have been placed for reference in the official collection; and a continuance of such favours is earnestly hoped for.

REPORT OF THE EXPERT ON FRUIT AND SPECIAL INDUSTRIES.

(*Jos. Knight.*)

In making a general report upon the progress, present condition, and future prospects of the various agricultural, horticultural, and other industries, which have been placed under my supervision by the Department of Agriculture, it is necessary that I should cover the period from the time of my appointment, in 1890, to the end of 1899. At the former date, and for some years previously, the question of increasing the products of the soil by the introduction of suitable but comparatively unknown crops, and the dissemination of sound cultural information among settlers, had attracted a considerable amount of attention, and a great deal was said and written respecting them. The outcome of this discussion yielded no useful results, however, as improvements in knowledge and practice, when left to individual efforts, are necessarily slow and uncertain. In order, therefore, to hasten the desired changes the Government took up the subject, and decided that it was desirable to give substantial assistance.

In the year 1889 the proposal was submitted to Parliament, which received it with favour, and liberally voted the sum of £233,000 to carry out the scheme. This sum was distributed in fixed proportions to assist specified agricultural, viticultural, horticultural, and special industries, the expenditure being mainly in the form of bonuses to be distributed during a series of years. This legislation had a wonderful effect in stimulating settlers then upon the land, and induced many others to turn their attention to agricultural and horticultural industries. Having been appointed inspector under the Bonus Regulations, to certify that the conditions prescribed by the regulations were duly observed by claimants, my services were soon in great demand, as applications came in rapidly from all parts of the colony.

Fruit planting received an extraordinary impetus when the bonus system came into force, and, as a consequence, a large number of young orchards and vineyards came into existence in various parts of Victoria. As a matter of fact, orchards and vineyards were planted in many localities where previously fruit culture was an unknown industry.

This result, however, was fully anticipated by myself and others interested in fruit culture, as the soils and climatic conditions to be faced in the various districts of the colony are adapted for the production of a large number of the most useful and popular edible fruits. Then, again, fruit culture is a more familiar and attractive pursuit for many who, for various reasons, are not eager to embark in special industries with which they have no practical acquaintance. So great and rapid was the extension of orchards and vineyards that the amount allotted for them under the bonus regulations (£75,000) was quickly exhausted, and, consequently, payments ceased some time back. In several of the other divisions bonuses have been applied for to a considerable extent, and, as a result, some useful soil industries will probably become of importance in the near future. These industries, and others, are dealt with in detail, further on in my report, under separate headings. It is, however, with regret that I have to call attention to the fact that, as regards several industries which promise well, and are certainly worthy of a trial, but little or nothing has been done under the bonus regulations to test them. This is the more surprising, as the crops are suitable for local conditions existing in various parts of Victoria, so far as relates to soil and climate, and in other countries they are carried on profitably, and rank as standard industries. These neglected industries are particularized as their classes are dealt with further on in my report.

In addition to the work of inspection and certifying as to claims under the bonus regulations, an important part of my duties is to advise cultivators as to the most suitable kinds and varieties for their requirements.

The necessity for information, in this respect, is a want that has been felt by many who, from inexperience and lack of technical knowledge, were in danger of making serious mistakes when starting new industries. I have advised upon the lines of selecting kinds and varieties best suited for the soil and climate of particular localities, and also the purposes for which the products were to be utilized. I have also made it an important part of my work to supply settlers with necessary information as to the cultivation of these crops and their preparation as marketable products. Instruction upon the lines mentioned I consider to be of the greatest importance to a large number of settlers.

In fact, I regard it as essential to every attempt to develop new or little-known industries. In support of this contention I must point out that the main bulk of our settlers can lay claim only to a very limited amount of technical knowledge as to the treatment of land and crops.

I have the great satisfaction of knowing that my efforts in spreading useful cultural and other information have been of substantial value to many settlers who, through starting with little or no technical knowledge, are now successful cultivators. My duties, however, are so multifarious and extend over so wide a range, that, of necessity, I am unable to devote as much time to giving instruction as I should like. In addition to being Bonus Inspector, I also hold the office of Fruit Expert, a position which alone might profitably occupy the whole of my time. The oil, fibre, perfume, and other special industries have also to receive my attention, and I have various other exacting duties to perform. In addition to my regular duties, I have, of late, had a good deal of my time occupied in supervising the shipments of fodder to South Africa on behalf of the Imperial Government. With such multifarious duties pressing on me, my time is so fully occupied that very often I am unable to give such prompt and careful attention to requests for information as I would desire.

Fruit-planting.

The bonus system is responsible for a great increase in the acreage under fruit. Under the regulations the amount paid as bonuses for planting is £20,000 for 12,500 acres of vines, and £21,200 for 8,333 acres of miscellaneous fruit trees and bushes, or a total of £41,200.

Speaking generally, the outcome from this expenditure has been satisfactory, though still better results were anticipated. Lack of knowledge and want of care on the part of the cultivator have, however, considerably retarded the development of the fruit-growing industry. Another serious drawback has been the want of facilities for securing export markets; though these exist, and are quite ready to absorb an unlimited quantity of fruit and its products at remunerative prices.

As regards the first drawback mentioned, a large proportion of those who started fruit-growing a few years back made the serious mistake of planting kinds and varieties

which were quite unsuitable for the purposes the cultivators had in view. Consequently, trees of this class have had either to be rooted up and their places filled with better sorts, or cut back and grafted with the desired varieties. In either case, growers have suffered through the loss of time in obtaining returns for their outlay. Mistakes of this kind, however, are less likely to recur in the future, as growers have now a better knowledge as to their requirements.

Respecting the difficulties connected with the export trade, experience has proved that they are unavoidable in opening up new markets for all kinds of products. They will, however, probably disappear as our fruit becomes better known, and the shipping arrangements improved.

There can be no question as to the great importance of the fruit-growing industry, which has certainly advanced materially during the last few years, notwithstanding various drawbacks, and its development will doubtless be still more rapid in the near future. As the colony embraces a wide range of climate and soil, it can produce to perfection an infinite variety of edible fruits, many of which are in great demand for commercial purposes. As a matter of course, the local demand for fruits and their products is large and rapidly expanding, and will always absorb great quantities of produce. The main dependence of Victorian growers, however, must be upon outside markets, which are open to receive practically unlimited quantities of fruit in various forms. There are both home and export markets available for the absorption of immense quantities of fruit in its natural state. The demand for dried fruit is considerable, and when canned it commands large and growing markets. Fruit, when prepared in the form of jams, jellies, and marmalade, is generally and extensively consumed. Then, again, there are fruit products, such as wine, cider, and other commodities, which are largely used. Consequently, fruit-growers, with so many outlets for the disposal of their products, need not fear over-production when the export markets are fully developed. These remarks, however, must be qualified by the provision that the most suitable kinds are grown for the various purposes, and that due care is taken in their cultivation. It is also essential to the development of the fruit-growing industry that all necessary care should be taken in preparing the produce for market, in whatever

form it may be utilized. Then, again, every precaution should be taken in packing for market, so that fruit or its products will reach its destination in the best and most attractive condition.

The Export of Green Fruit.

The amount paid under the bonus regulations for green fruit exported up to the end of 1899 is £6,436. Though the progress of this trade may be considered to be moderately satisfactory, yet, in some respects, it has been disappointing. This trade is of considerable importance to Victorian fruit-growers, consequently its free development is greatly to be desired. There are, for a certainty, large and payable markets in the United Kingdom for various fruits that can be grown to perfection in the colony. Then, again, there are prospects of markets being opened up in other parts of Europe, as also India and, possibly, America; but in order to allow the export trade to develop freely, growers must be careful to send away fruit of the highest quality only, packed in the most suitable manner, and shipped under such conditions that it will arrive at its destination in the best possible order. Let these conditions be complied with—and there is no reason why they should not—and Victorian growers have markets open to them for practically unlimited quantities of green fruit.

The principal fruits exported hitherto have been apples and pears, the former, as a matter of course, preponderating largely. Generally speaking, these shipments have given fairly payable returns, and some of the consignments have realized high prices. On the other hand, in not a few instances, shippers have been less successful, and some have been out of pocket by their ventures. Want of success, however, in most cases has resulted, either from carelessness in packing, or through the fruit lacking the high quality that is so essential in the English market.

Grapes have been exported to a limited extent, but the results have not afforded much encouragement to shippers. The consignments have arrived at their destination in varying conditions, from sound and perfect to absolutely rotten and worthless. In but few instances were payable prices obtained, while, in many cases, the fruit was unsaleable, and consequently entailed losses upon shippers. Possibly these unfavorable results are due mainly to defective packing,

and the sending of unsuitable varieties. Notwithstanding the poor general results from the past efforts to develop an export trade in grapes, I am of opinion that future success is quite possible if a better system of selecting and packing is adopted.

Only specially-suitable varieties must be used for an export trade, and these should be packed with every possible care. There are several varieties that are suitable for the purpose, so there need be no difficulty on that point. In the United Kingdom there is an extensive market for high-class table grapes, and it would be greatly to the advantage of Victorian growers if they could obtain a fair share of this trade.

There are, in my opinion, several causes that militate against the development of the export trade in green fruit. In the first place the transport charges are so heavy that only the highest London prices will cover the cost, and afford a fair margin of profit to the grower and shipper. If, from various causes, medium or low prices have to be accepted, they may possibly mean no profit to the shipper, or worse still, a positive loss. Various efforts have been made to lower the freight charges by treating fruit specially, so that it could be shipped without requiring cool chamber storage. So far, however, these efforts have produced no practically useful results, and may be regarded as mere experiments. Possibly the time is not distant when some means will be discovered which will enable green fruit to be carried by ship at much lower rates than those now existing. When this object is attained, as it will be sooner or later, the export trade in green fruit must necessarily largely increase.

The arrangements for the export of green fruit from Victoria are, in my opinion, not so satisfactory as could be desired, and they might be materially improved in the interests of the growers. Greater facilities are required to enable exporters to ship their fruit easily and with certainty. Under existing conditions ordinary growers are at a disadvantage in comparison with the larger orchardists and regular shippers, who, having experience, are able to make their arrangements earlier in the season.

This practice enables a few people to secure all the available space in any particular ship, and this is generally limited. Consequently other would-be shippers have their consignments refused through want of room in a vessel. Another great drawback to many growers, is the custom of

having to pay in advance when space is booked, often a long time before the fruit is ready for shipment. A large number of growers who would like to enter upon the export trade are unable to make definite arrangements before their crops have matured, and consequently they are placed at a disadvantage under this system.

In my opinion a radical change is required in the present system of inspecting and packing green fruit for export. According to existing arrangements, fruit that has to be inspected is simply placed on open wharfs alongside the vessel in which it is being shipped.

Under such conditions it is really impossible to inspect the fruit in the thorough and systematic way that it ought to be done. A better system is urgently required, and I would suggest that a special receiving depôt should be established in Melbourne, provided with the necessary conveniences, to enable the work of inspection to be done thoroughly and expeditiously. Further, I would suggest that several provincial depôts should be formed in the principal fruit-growing centres. The adoption of this suggestion would enable many growers to share in the export trade who otherwise must hold back owing to the difficulties in the way.

At these depôts, the fruit could also be re-packed and graded properly, growers being too often careless in these respects. The extra expense that would be incurred in carrying out my proposals could be fully covered by making a small charge per case for the fruit sent in.

According to my experience, fruit for export to the United Kingdom would be placed under the most favorable condition if it were graded, packed, and treated by men who make it a special business, and have the necessary conveniences for carrying on the work. In support of my opinion I may state that, last season, the Department made arrangements with an English shipping firm to re-pack and cool down a portion of the consignments, and the results were very satisfactory. I feel confident that by increasing the facilities for getting the fruit to central depôts, where it could be properly treated, growers would be greatly benefited.

Then again, the knowledge that large quantities of prime fruit were passing through a metropolitan or other receiving depôt might probably be an inducement to English firms to become direct buyers, and this would be greatly to the advantage of growers.

Dried Fruits.

Fruit-drying has become a very important industry in several districts in Victoria, and more especially at Mildura and in the Goulburn Valley. The leading fruits are raisins and apricots, both of which are now produced in considerable quantities. There has been steady and rapid progress in the production of these fruits, and the industry, judging from results, appears to be well adapted for many of our inland districts.

The amount distributed under the bonus system to encourage the drying of these fruits is £7,000, and, for this expenditure, very satisfactory results have been obtained. The requirements for consumption in Victoria of both raisins and currants are now chiefly met by locally-produced fruit, and considerable quantities are exported to the other colonies, England, and elsewhere. I may mention incidentally that a considerable portion of the raisins and currants made in Victoria goes direct from the producers to the consumers or retail traders, consequently the intervention of agents or middlemen is to a large extent avoided, to the great advantage of both growers and consumers.

Fig-drying, I regret to say, has made little or no progress, though it is an industry well suited for the warm interior districts. This fruit thrives to perfection in many localities, and produces crops equal in yield and quality to those obtained in the fig-drying districts of Europe and Asia Minor. A few growers have tried their hands at drying, mostly on a small scale, but, generally speaking, the results have not been satisfactory. Among the limited number of exceptions a few fairly good samples have been produced, yet in the great majority of cases they have been inferior and quite unsuitable for commercial purposes. There is, however, no reason why figs, quite equal to those that are imported, should not be produced in Victoria.

We have a congenial climate and soils, as proved by the excellent crops of figs that are produced in many localities, and the other essentials to success are simply, in the first place, the use of suitable varieties, and then the proper treatment of the fruit in the processes of drying and packing.

The foregoing remarks will, in a large measure, also apply to the drying of prunes, an industry which, I regret to say,

has received but little attention. This is somewhat surprising as the demand for this fruit is considerable and the kinds of plums suitable for the purpose thrive well in many parts of Victoria. I anticipate, however, that this promising industry will receive greater attention in the future.

The drying of apricots has become an extensive and important industry in Victoria, large quantities of fruit being now utilized for the purpose.

The local demand, which is considerable, is now mainly supplied by Victorian-cured apricots, which, both for quality and price, can hold their own in competition with imported fruit. Mildura and the Goulburn Valley are the chief centres of production, but excellent samples are also made in various other localities. As the apricot flourishes throughout a considerable portion of Victoria, I believe that the production of dried fruit will necessarily, steadily, and largely increase.

This way of utilizing apricots must commend itself to many growers who have suitable varieties, as it assists in preventing the markets from being over-supplied with fresh fruit. Peaches are dried to a considerable extent, though this fruit received less attention for this purpose than apricots. As regards the future of the peach-drying industry and the localities most suitable for it, the remarks on the apricot will equally apply. Strange to say the drying of apples has received but little attention in Victoria, though growers are numerous, and this mode of utilizing the fruit may be practised with advantage under certain conditions.

Growers often find some difficulty in obtaining a good local market for fresh fruit, and, when such happens, they would probably turn their produce to better account by drying it. There is a large and steadily increasing local demand for dried apples which, if met by Victorian-cured produce, would absorb large quantities of fruit. Respecting dried fruits generally, I may remark that, in addition to our large and expanding local markets, any surplus that may be produced can be profitably exported to the United Kingdom and other countries. Consequently, Victorian growers have a wide field to work in as regards the production of dried fruits, and it would be well if they gave increased attention to this industry.

Canned Fruit and Preserves.

The preservation of fruit by canning and the manufacture of jams, jellies, &c., have of late years become somewhat prominent industries, though I regret to say they have not made such satisfactory progress as could be desired. Canned fruit is now used to a considerable extent in this and the neighbouring colonies, and the demand is supplied, in a large measure, by Victorian products. Manufacturers however have not, as yet, succeeded in developing an export trade to the United Kingdom and other parts of the world, though, some few years back, a limited number of small shipments found fairly good sales in the London market.

Consignments to that market have gradually fallen off, and latterly but little, if anything, has been done in this direction. Possibly this trade will be developed in the future, as there is in Europe a considerable demand for canned fruit, now mostly supplied by American products. Australian manufacturers ought, however, to be well able to hold their own in a competition for this trade. A large proportion of the people in the United Kingdom prefer glass receptacles to tins, as they like to see the articles they are buying. If Victorian preservers could see their way to send fruit in glass, it would doubtless find a ready sale, possibly the increased cost might prove a bar, but the question is worthy of consideration.

Jams, jellies, and marmalade, as exportable commodities, are placed at a disadvantage, owing to the low price of sugar in the United Kingdom, which enables preserves to be made at very cheap rates. But, though the development of an export trade under existing conditions may be doubtful, yet, in my opinion, the preserved fruit industry can be extended considerably in the Australian colonies. If my conclusions are correct, a much larger quantity of fruit will, in the future, be utilized for this purpose than at present. With great regret I have to express my opinion that, too frequently makers of preserves do not take the requisite care in purchasing fruit for their trade. Large quantities of very inferior fruit are utilized in the form of preserves. Sometimes the fruit is unripe and deficient in flavour, not infrequently it is over ripe, or in a state of decay more or less ; then again it is often bruised and unsaleable for other purposes. No greater mistake can be made by the makers

of preserves than the use of inferior or damaged fruit, from which high-class jams, jellies, &c., cannot possibly be made. In making these remarks, as a matter of course, I do not wish it to be inferred that all manufacturers use inferior fruit in their business, but unfortunately a good many follow this bad practice.

Fruit Pulp for Export.

Though the export trade to the United Kingdom and other parts of Europe for completely prepared fruit has hitherto been limited, yet a considerable and growing demand has arisen for the pulp of certain kinds.

The opening of this trade promises a good outlet for some kinds of fruit, as the market is large and practically unlimited. Consignments hitherto have always found a ready sale, and realized satisfactory prices.

This season the trade promises to show a considerable increase in the shipments. So far the fruits that are being turned to account for pulping are apricots and raspberries, though probably in time other kinds will be utilized for the purpose. The opening of this trade has been of special advantage to raspberry growers, who previously often found a difficulty in disposing of their crops in the local market at satisfactory prices. I may observe that when the bonus system came in operation, the allowance of £1 10s. per acre for planting raspberries caused a rapid expansion of the area under this fruit. Consequently a much larger quantity of fruit was produced than previously, and, being in excess of local requirements, growers often experienced a difficulty in finding a payable market. As a natural result of such a state of affairs, many disappointed growers uprooted their plantations and substituted other crops. When however it was proved that, in the United Kingdom, there was a good market for pulped fruit, growers' prospects were materially changed for the better, and the drawback of over-production at once disappeared.

The opening and development of the export trade in pulped fruit is due entirely to the bonus of ½d. per lb. given by the Government, the expenditure for this purpose amounting to £634. Since this trade has been opened up, growers have been able to get very much higher prices for their raspberries than previously, and there is a practically unlimited demand. In fact prices are now nearly double what they were a few

years ago. This mode of utilizing fruit has also been of great service to growers of apricots, and materially helped to maintain good selling prices. I must observe, however, that it is essential to the success of this trade that the pulping factories should be in the centres of production, so that the rich flavours of the fruit may be conserved to perfection. When carried long distances, and allowed to stand any length of time before it is pulped, the fruit is likely to lose some of the high flavour it possesses when fresh gathered, and this contingency must be avoided as much as possible. When the trade first commenced, information was obtained from competent authorities that, for the London market, it was necessary that fruit pulp should be exported in small tins. This advice was acted upon as regards apricot pulp, which has always been shipped in the way recommended. In the case of raspberry pulp, however, influence was brought to bear in favour of tins of larger size, in order to reduce the cost, and this proposal was assented to. The tins used under this concession held from 40 to 45 lbs. This alteration, however, proved to be a great mistake, as we learn from Mr. Sinclair, the agent in London. This gentleman informs us that pulp is of much better quality, and more saleable, when sent in small tins. He also informs us that every care must be taken in shipping to the London market.

Citrus Fruits.

I consider it desirable to specially mention these fruits as, in my opinion, they are deserving of more general attention than they have hitherto received. Trees of the Citrus family, when planted in localities where the conditions for growth are favorable, and proper care is bestowed upon them, will generally give larger and more reliable returns than most summer fruits. Experience has proved that trees of this family will thrive in many localities where the frosts are not severe and the soil can be kept moderately moist during periods of drought. An open, well drained, and fairly rich soil, as also shelter from high winds, is essential to the cultivation of Citrus fruits. It is commonly supposed that Gippsland has a climate quite unsuitable for these fruits, but such is not the case, as, to my own knowledge, trees of this family are thriving in many parts of that extensive district. Lemons are more hardy than oranges, and may be grown successfully in many localities, provided they are

well sheltered, and their other requirements duly cared for. Oranges and lemons are in great and increasing demand in Victoria, but, at the present time, locally-grown fruit represents only a very small portion of the quantity consumed. At present the main bulk of the fruit used in this colony comes from New South Wales, but there is no reason why Victorian growers should not get a much larger share of this trade in the future. There is a large and good market open to growers if they will make an effort to supply local wants. After supplying the local markets, growers need have no fear of an over production of fruit, as any surplus may be turned to good account by opening up an export trade to England.

As citrus fruits keep and carry well, they are admirably adapted for an export trade. New South Wales at present exports oranges in large quantities to Great Britain, and when planting becomes more general, Victorian growers may also get a share of this trade. We may also reasonably anticipate that, as time advances, the products of citrus fruits, such as marmalade, candied peel, orange wine, lemon juice, &c., will receive attention for commercial purposes. Excellent specimens of these various products have been prepared in the colony, but only experimentally, to show what could be done. As regards the production of marmalade, I may state that the Seville or bitter orange is more hardy than the sweet varieties, and thrives well in many localities where the ordinary kinds are difficult to grow. The demand for these oranges in Victoria is considerable, and is chiefly met by imports from the neighbouring colonies.

The scarcity of Seville oranges is a great drawback to the trade in this colony, and my attention has been frequently called to this matter by factory managers. There would be a large and profitable market for this fruit were it more generally cultivated, and settlers would do well to give it more attention.

Cider Making.

But little has been done in Victoria in the way of making cider, though some very good samples, in a small way, have been made in various districts. In my opinion, however, cider-making is an industry well deserving the attention of fruit-growers as it affords a means for utilizing produce that

otherwise might be wasted through the lack of a market. Where apples are largely grown, cider-making affords what may be termed a safety-valve against over-production and poor markets.

Though certain varieties, specially known as cider apples, are better suited to the purpose than others, yet any variety may be utilized in this way. In order to obtain good cider, the principal requirement is a juice that contains certain properties of sweetness and acid. The higher the proportion of saccharine in the juice, the greater will be the alcoholic strength, and the better will be the keeping properties of the cider. At the same time, however, care must be taken to guard against an excess of acidity. As regards the proportion of acidity required, the amount is about six-tenths of a degree. Certain results in these respects may be obtained by testing the juices of the apples used, which is easily accomplished by simple instruments, the use of which can be readily acquired.

Complete instructions in all matters relating to the making of cider has been given in a *Guide to Growers*, issued by the Department of Agriculture. The above-mentioned combination of sweetness and acid is to be found to the greatest perfection in the recognised cider apples. The required result, however, may be obtained by judiciously blending the juices of varieties differing in character. Cider of good quality. if made in quantity, would probably find a payable local market, and more especially during the summer months. Pears, and more especially the culinary varieties, may be properly utilized in the same way, when fruit is abundant and prices low. An excellent cider can also be made from peaches, and in localities where that fruit is abundant, growers will probably find it to their advantage to give some attention to this industry.

Fibre Crops.

With the advent of the bonus system, a number of settlers began to turn their attention to the growing of various crops yielding products largely used in commerce. Prominent amongst these crops, are those yielding the principal commercial fibres, for which there is a large and practically unlimited demand in Europe. The cultivation and preparation of these crops in various countries, are staple agricultural industries, and large areas are devoted to them. As

the climatic and other essential conditions for the successful culture of many of these commercial fibre plants exist in Victoria, there are good reasons why settlers should give some attention to them. Flax is the crop that has hitherto received the greatest share of attention, a number of settlers having started its cultivation soon after the bonus regulations came into force, both for fibre and seed. The sum paid as bonuses for crops of flax and hemp up to the end of 1899 amounts to £354. Flax has been grown successfully in widely different localities, and it appears to be a suitable crop for many parts of the colony. It has, however, received the largest share of attention in Gippsland, where it thrives to perfection.

When the industry started, a few years ago, a good many settlers turned their attention to it, but afterwards there was a considerable falling-off, and the number of cultivators was greatly reduced. The principal reason for this falling-off was a succession of dry seasons, causing a partial failure of cereal crops, and therefore an increase in the value of grain, consequently the greater attention paid was to them. Last season, however, the area under flax showed a substantial increase as compared with the previous year. In my opinion, there are good reasons for anticipating that the cultivation of flax will become a progressive industry in Victoria. It should certainly prove a remunerative crop, as the results obtained hitherto show returns of from 6 to 8 cwt. per acre of marketable fibre. So far, the fibre produced has been absorbed in the colony, where it is in good demand for making cordage, at a value of about £40 per ton. Messrs. James Miller and Co., of Melbourne, have been the chief purchasers, and they have paid as high as £42 per ton for specially good samples. Though nothing has been done in the way of an export trade, yet we must bear in mind that in the United Kingdom there is practically an unlimited demand for flax, and, with this market open to them, growers need not fear over-production. As regards the quality of Victorian-grown flax, samples sent to England have been pronounced excellent by high authorities. A few growers are now cultivating flax as a regular farm crop, and are quite satisfied with the results. I know two farmers who have successfully grown flax for several years, and they regard it as a profitable crop. These farmers give, as an additional reason why this crop should receive attention, that the necessary labour is chiefly required

at times when it is not in great request for other farm purposes. Perhaps the greatest drawback to the cultivation of flax is the cost of the necessary machinery for preparing the fibre, which amounts to from £60 to £70, without the motive power.

Hemp has been grown to a far less extent than flax, though in several localities it has yielded good crops, while it has done remarkably well in the humid parts of Gippsland. Both the Russian and the Italian varieties have been grown, with about equal results, the yields obtained averaging from 10 to 12 cwt. per acre of marketable fibre.

There is a good demand in the colony for the fibre for making cordage, its value ranging from £28 to £30 per ton. The seed is also in fair local demand, and is worth from £10 to £12 per ton.

Both of these products should find a good export market in Europe, where the demand is extensive and rapidly expanding. Hemp is deserving of greater attention in localities suitable for its cultivation, where it will doubtless prove a remunerative crop. The principal reason why this crop has not hitherto received more attention is, in my opinion, owing to the want of more perfect machines for preparing the fibre.

New Zealand flax (*Phormium tenax*) has received no attention in Victoria as a fibre plant, though it thrives to perfection in many localities. It is a plant specially well adapted for low-lying land along the banks of rivers and creeks, and would probably be found a useful crop for reclaimed swamps. As a crop, this plant will yield a very large return in bulk of leaves, which may be removed by a succession of cuttings at various times of the year. The crop has the advantage of being permanent, and will stand for several years without the necessity for renewal. The fibre is in great demand in Europe, and always commands a payable price. The reason why this useful fibre plant has been hitherto so greatly neglected is probably owing to the fact that the fibre is prepared with some difficulty, special treatment and machinery being required. This drawback, however, will probably disappear in the future, as recent improvements in machinery and treatment have greatly simplified and cheapened the process of extracting the fibre.

Ramie, or the Chinese grass cloth plant (*Boehmeria nivea*), has for years been grown in a small way in many

parts of the colony. Cultivation, however, has been merely experimental, and the fibre has not been turned to account commercially. Probably this plant would have received more attention had the preparation of the fibre been less difficult.

Until recently the process was complicated, and required special skill and machinery. Recently, however, the system of treatment has been greatly simplified by the invention of improved machinery, and in other ways. There is now no need for growers to trouble about preparing the fibre themselves, all that is necessary being to strip the bark, dry and pack it in bales, and ship it to England, where it can be readily sold. As the Ramie will thrive in any ordinary good soil, and yields a large bulk of valuable fibre, its cultivation is certainly worthy of attention as a commercial plant, now that the great difficulty in the way of treatment has disappeared. I have faith in the future of this plant, and can strongly reccommend it for extensive and general cultivation. A small plot has been planted on the new farm at Leongatha, to bring this plant under more general notice, and to furnish a supply of plants for distribution.

Rita and Sissel hemp are fibres largely used in Europe, but so far these valuable products have received no attention in this part of the world. These fibres are obtained from two species of the Agave family, a class of plants that thrive to perfection in the driest and hottest districts, and whose growth is quite independent of the rainfall.

As these plants are well adapted for our dry interior regions, their cultivation should prove profitable in many localities, and they are certainly worth trying. Both of the species yield large crops of fibre that will always command a ready sale and good prices in the European markets. Being permanent plants, they will yield crops for several years without the expense and trouble of renewal. Cultivation is simple, and the crops require very little attention after planting; all that is necessary being to keep down weeds. I may state that these plants are to be found growing in gardens in many localities.

Oil-yielding Crops.

Several of the plants yielding the principal vegetable oils of commerce have been grown successfully in various parts of the colony, but chiefly in Gippsland. The area devoted

to this class of plants, and, for which, applications were made under the bonus regulations, are as follows:—Flax, 4,007 acres ; sunflower, 1,424 acres ; and rape, 874 acres.

Rape was grown rather extensively a few years ago, and many excellent samples of colza oil were produced. Seed in considerable quantities is obtained in some parts of Gippsland, owing to the common practice of using rape on newly-cleared forest land. This crop is also considered to be serviceable in protecting the young grass, and for supplying an early bite for stock when ordinary feed is scarce. After being eaten down, the plants usually make a heavy growth in spring, and yield large crops of seed. A considerable portion of this seed was formerly used for making oil, but owing to the falling-off in the demand for this commodity, and the consequent difficulty of effecting sales, the production of colza in Victoria has almost ceased. The same drawback exists in respect to several other vegetable oils, whose places have been taken, for lubricating and other purposes, by cheaper mineral productions.

Linseed, a few years back, received a good deal of attention for making oil, and some excellent samples have been produced, chiefly in Gippsland.

A succession of dry seasons, and consequently poor crops, however, caused a good many settlers to give up the cultivation of this crop, and therefore production was materially reduced. During the past season, however, this crop has received increased attention, and, its cultivation being long past the experimental stage, I am of opinion that the making of linseed oil may be regarded as a coming industry. Some growers have been very successful in growing this crop for the double purpose of obtaining both seed and fibre. I would strongly recommend this practice, being thoroughly convinced, from what I have seen, that it is a sound one.

Ordinary good crops will produce from 15 to 20 bushels of linseed per acre. The yield of oil averages from 28 to 32 per cent., according to the quality of the seed.

There are several varieties, and these, as a matter of course, have given varying results, but in no case have the differences been considerable. An Indian variety with very large seeds, known as the Large Red, has proved to be one of the best kinds for oil, as it yields about 2 per cent. more than the Riga or Dutch, but it is of less value for a fibre

crop. For fibre and seed crops combined, the Riga has proved the most serviceable variety. A kind known as the White-flowering Belgian has proved a valuable variety under some circumstances, as it matures more quickly than other sorts, and is suitable for spring sowing.

Seeds of this variety were distributed, through the Department, in seven districts, and, in each one, satisfactory results have been obtained.

This variety in habit is slightly more dwarf than the Riga or Dutch, but yields an equal quantity of seed and oil. In localities where late sowing is a necessity, this variety is specially useful, owing to its quick-maturing tendency.

The sunflower, as an oil-yielding plant, has received a considerable amount of attention, and more particularly in Gippsland. It is a plant that can be grown with a little care ; it matures in a short time, and yields a heavy crop of seed, qualities that strongly recommend it to farmers who are desirous of trying special industries. This industry, for a time after it was started, gave good promise of being progressive, but latterly the cultivation of the sunflower has fallen off considerably, owing to the difficulty in finding a payable local market for the oil.

Though of excellent quality, and this oil is considered by many competent judges to be little, if any, inferior to the product of the olive, yet the fact remains that the local market is almost closed against it.

Victorian traders have hitherto shown reluctance to recognise the merits of sunflower oil, and they, as a rule, appear to have strong prejudices in favour of the imported kinds with which they are more familiar.

These prejudices must necessarily disappear in time, as the oil is of a high class, and, when better known, is certain to be in good local demand.

The sunflower is a very prolific plant, and crops grown under favorable conditions will yield from 70 to 80 bushels of 40 lbs. each per acre. There are, however, many varieties, and some yield much larger quantities of oil than others. Unfortunately growers often raise crops from varieties that are poor in oil, and, consequently, they fail to get satisfactory returns. According to the results obtained from seed, with the mill imported by the Department of Agriculture, the yields of oil ranged from 6 to 20 per cent., a very wide difference. In fact, so poor was the oil yield in some cases that

large quantities of seed sent to the mill for treatment were left uncrushed, as it would not pay for working. The highest return obtained was from a variety with small brown seed, grown in the Traralgon district, which gave a yield of 20 per cent. A black seeded variety grown by Mr. J. Ferguson, of Bairnsdale, gave a return of 18 per cent. and a very heavy yielder.

The cake from this variety was of very excellent quality, being almost equal to that made from linseed, and found a ready sale for feeding purposes. Though at present there are obstacles in the way, which will take some little time to overcome, yet I am of opinion that the production of sunflower oil may be ranked as a coming industry. As a matter of course, a good market for the oil is essential, but I have no doubt this will be found in Europe, the main requirement being the opening up of an export trade.

The cultivation of the olive for oil is making no progress; in fact, this tree appears to be quite neglected by settlers. There are various causes for this unsatisfactory state of affairs. In the first place, there is the drawback of the trees having to be planted for a number of years before they will yield payable crops, whereas colonial settlers, as a rule, require quick returns from their land and labour. The cost of harvesting the crop is another drawback to the cultivation of the olive, as the work of picking is both slow and tedious.

Probably, however, the principal reason for the neglect of this point is the falling off in the value of oil, owing to the more limited demand than formerly existed. This lessened demand is due to the fact that other and cheaper vegetable oils have, to a very large extent, taken the place of the product of the olive. In fact, these more easily-obtained vegetable products are, to a very large extent, now commonly sold as olive oil, either when mixed or in their pure state.

Castor oil of good quality has been produced in various parts of the colony, but, owing to various causes, this industry has not progressed. The largest yield was obtained from an Indian variety of *Ricinus communis*, which was specially introduced for the purpose.

Seeds of this variety proved to be much richer in oil than the common kinds which are so often met with in gardens, where they are grown as ornamental plants. This Indian

variety is, however, much more tender in habit than the common kinds, and appears to be unable to withstand the climate of Victoria in the winter season. In fact, this variety has been completely killed by frosts in localities where the ordinary kinds have not been the least affected. But, even supposing that more hardy varieties were cultivated, as rich in oil as the Indian one mentioned, I am of opinion there is little encouragement in Victoria to produce castor oil, owing to the demand having materially fallen off of late. This result has been brought about by the more general use of cheap mineral oils for lubricating purposes.

No other plants, excepting the ones I have mentioned, have, as yet, received attention for oil-making, though several are certainly worthy of a trial.

The Government Oil Mill.

When the cultivation of oil-yielding plants commenced under the bonus regulations, it was found necessary, as no mills were available for crushing the seeds, that the Government should import one, so that growers would have the necessary facilities for utilizing their crops. Consequently, a mill was imported, one of the most perfect that could be obtained, and this was placed under my charge. An expert was engaged to attend to the working of the mill, which was sent to various districts, the principal stations being Bairnsdale, Ballarat, and Melbourne.

At each of these places, considerable quantities of seeds were treated; no charge being made for the work done. I may also say that the working of the mill excited a good deal of interest, and gave general satisfaction. Afterwards other mills were introduced by private enterprise, which it was deemed advisable to encourage. A bonus of 1s. per gallon is given for oil produced by these mediums. The amount expended for this purpose is £250, representing 5,000 gallons of oil. As the quantity of seeds produced is not large enough to fully supply the private mills the Government one was withdrawn from work, it being deemed inadvisable to compete with private enterprise. Consequently the mill is now idle, but I have recommended that arrangements should be made for utilizing it by persons who can find work for it.

Perfumes and Essential Oils.

In order to encourage the production of various perfumes and essential oils used in commerce, special attention was given to plants suitable for the purpose in framing the bonus regulations.

A comprehensive list of desirable plants was published, and a bonus of £2 per acre was offered for their cultivation. Stringent provisions were, however, made that the crops should be effectively utilized by distillation, or other means, before they would be entitled to a bonus. Soon after the regulations were published, a large number of applications were made, and these were added to from time to time. When the crops were grown, however, applicants found that it was difficult, and in many cases impossible, to utilize them as intended, owing to the stringency of the Customs regulations. These provide that every person using a still shall obtain official permission, pay a license fee of £2 per annum, and find two sureties to the amount of £200. The cost of the still and other necessary appliances, as a matter of course, entailed an outlay, and this was also a serious consideration with many of the growers. Consequently most of the applicants decided to abandon the work, and their crops were not utilized as intended. The state of affairs was, to say the least, most vexatious to the applicants, as, not anticipating such difficulties, they had gone to the expense of putting in crops that, after high expectations, proved to be valueless. The matter was brought under the notice of the Customs authorities, who in reply stated that it was incumbent upon them to administer the law as they found it, and that they had no power to treat any particular class of people exceptionally.

While such a state of affairs exists, it is clear to my mind that no advancement in the industry of producing perfumes and essential oils can take place. If not encumbered by these stringent Customs regulations, this industry would, probably, make good headway, as it affords a suitable avocation for females and others who are physically unable to perform more laborious work. The cultivation of scent-yielding plants should certainly be a progressive industry in Victoria, as the climate is similar to that of the South of France and Italy, where the business of perfume-making is so extensively practised.

Experience has proved that nearly all the plants commonly used for the production of commercial perfumes and essential oils can be grown to perfection in Victoria.

Though the applications under the bonus regulations were numerous, as previously stated, yet only a very small number were able to comply with the conditions, for the reasons mentioned in the foregoing remarks.

The total amount paid for this class of crops only amounted to the sum of £38, representing 19 acres. As regards the utilization of these particular crops, they were mostly treated by stills erected for other purposes.

The Dunolly Scent Farm.

One of the methods of calling public attention to those special industries a few years ago, was the establishment of the Dunolly Scent Farm by the Board of Viticulture. This action was, by some people, considered to be somewhat singular, as the growing of scent-yielding plants has certainly nothing in common with viticulture.

The farm was placed under the control of Mr. F. Mellon, and in the first year 20 acres of land were cleared, fenced, and three planted with various essential oil-producing plants. In the following year, more land was planted and a still obtained, by means of which small quantities of various oils were secured. The next season the whole of the 20 acres of cleared ground was placed under crop, and a large still obtained, so as to allow operations to be conducted upon commercial lines. A plot of vines was also planted, in order to obtain a supply of spirits of wine, the use of which is necessary in the treatment of essential oils. In 1895, the cultivated area was considerably increased by the addition of another 20 acres, which were planted with various perfume-yielding plants. Two acres of the white mulberry were also planted, with a view of obtaining cuttings for public distribution.

Upon the retirement of Mr. J. J. Shillinglaw from the position of Secretary to the Board of Viticulture, the Dunolly Scent Farm was placed under the control of the Department of Agriculture, which, up to then, was in no way responsible for its existence or management. In 1897, Mr. Mellon, the manager, was relieved from his charge, and the care of the place was given to Mr. T. Burns,

who has been employed upon the farm from the commencement of operations. When this change was made, I received instructions to visit the place from time to time, to advise and report upon the system of working. After a few visits, and careful consideration, I came to the conclusion that the site was quite unsuitable for the purpose to which it has been devoted, owing to the indifferent character of both the soil and sub-soil. I found that, as a result of the inferior quality of the land, in many of the plots, plants were continuously dying off in large numbers. In some cases entire plantations disappeared, while in others three-fourths of the plants died off. Among the plants that disappeared entirely were peppermint and kindred species. The conditions for cultivation being so unfavorable, I was convinced that the farm could not possibly give satisfactory results, and felt that it was incumbent upon me to recommend a change of locality. My recommendation was adopted, and after careful consideration, a new site for a scent farm was selected at Leongatha.

Plants Cultivated at the Dunolly Scent Farm.

A large number of scent-yielding plants have been grown on the Dunolly farm, including most of the kinds from which the principal perfumes and essential oils are made. Many of these, however, have proved valueless from a commercial point of view, either through the climate or soil being uncongenial, or from other causes.

List of Plants Grown at Dunolly.

Absynthe (Artemesia Absinthium).
Aniseed (Pimpinella).
Cassia (Acacia Parnesiana).
Diosma.
Eucalyptus (lemon-scented) (Eucalyptus Citrodora).
Geranium Africa (Pelargonium Odoratissimum).
Geranium Rosa (Pelargonium Roseum).
Jasmine (Jasminum Officinalis).
Jonquil (Narcissus Jonquilla).
Lavender spica (Lavandula Latifolia).
Lavender stoechas (Lavandula Stoechas).
Lavander vera (Lavandula Vera).
Orange (Citrus Vulgaris).

Orris (Iris Florentina).
Peppermint (Mentha Piperita).
Pennyroyal (Mentha Pulegium).
Rose of Grasse (Rosa Centifolia), Provence Rose, Cabbage Rose.
Rosemary (Rosmarinus Officinalis).
Sage (Salvia Officinalis).
Spanish Broom (Spartium Junceum).
Tansy (Tanecetum Vulgaris).
Thyme (common) (Thymus Vulgaris).
Thyme (lemon) (Thymus Citriodora).
Thyme of the Alps.
Thyme (wild) (Thymus Serpillum).
Tuberose (Polianthes Tuberosa).
Verbena (lemon-scented) (Aloysia Citriodora).

Results Obtained at Dunolly.

From the results obtained at the Dunolly Scent Farm, I have come to the conclusion that, out of the many plants cultivated, only five have given satisfactory results commercially, and, consequently, these are the only kinds worthy of attention. These plants are lavender vera, African geranium, roses, peppermint, and rosemary. In fact, I think that this list might even be reduced to three kinds, namely, lavender vera, roses, and African geranium. The results obtained from these plants were as follows :— Lavender vera, planted out 3 feet by 4 feet, numbered 3,630 plants per acre. The yield of a plantation when three years old is from 40 to 50 pounds of oil per acre, the market value of which is from 7s. to 10s. per pound. African geranium, planted the same distance apart as lavender, gave a yield of about 20 pounds of oil per acre, valued at from 20s. to 30s. per pound, according to its quality. This I consider to be one of the best scent-yielding plants, while, at the same time, its propagation and cultivation is simple and easy. Provence roses are planted at the same distance apart as the two previously named plants. A great deal more labour is, however, required in securing the crop, as it is necessary to pick the flowers as they open out, and they must be treated soon after being gathered. According to the experience of Mr. Burns at Dunolly, an acre of roses has yielded about 15 cwt. of flowers. When distilled, three tons of flowers have yielded one pound of oil. It must, however,

be mentioned that the local conditions at Dunolly are decidedly unfavorable for the growth of roses, and the plants were seldom in a flourishing state. The value of the oil of roses varies somewhat, ranging from £2 10s. to £3 per ounce, or from £40 to £50 per pound. I am of opinion that roses may be profitably cultivated when the labour of children can be made available for picking. Otherwise, it is doubtful whether success can be attained, as the cost of men's labour is too heavy. Peppermint, when growing under favorable conditions, will yield from three to four tons per acre of material for the still. The amount of oil obtained is from six to seven pounds per ton, valued at from 15s. to 20s. per pound. This plant has the advantages of being hardy, easily cultivated, and is harvested with little trouble.

Rosemary is a plant well worthy of attention, as there is a large and increasing demand for the oil at remunerative prices. This plant is also easily grown and readily harvested. Probably some of the other plants in the list of those grown would prove profitable, if cultivated under more favorable conditions than those existing on the Dunolly Scent Farm.

Closing the Dunolly Farm.

Owing to the unsatisfactory state of affairs in relation to the Dunolly farm, as disclosed in my report, the Minister determined to close it, and early in 1899 gave orders to that effect, and I was instructed to look for a more suitable locality for an experimental farm.

After careful consideration, it was decided that Leongatha afforded certain advantages, and consequently a site in that locality was chosen. As soon as this arrangement was made, steps were taken for the removal of the stills and other appliances to the new locality. Preparations were also made for the removal of the standard plants and nursery stock. Unfortunately, however, some considerable time elapsed before the arrangements for the new site were completed, which, as also the efforts by residents of Dunolly to retain the farm in the district, caused unavoidable delay. Consequently the season got too far advanced for the plants to be all moved with safety, and it was impossible to finish the work without the risk of serious losses. Operations therefore necessarily had to be postponed till the next planting

season. Arrangements, however, were made for Mr. Burns to remove to Leongatha and take charge of the operations. At Dunolly a boy was engaged to look after the plantations and buildings.

The New Experimental Farm at Leongatha.

In selecting a site for conducting further experiments with perfume-yielding and other economic plants, various matters had to be considered. Several localities were carefully inspected, and, after mature consideration, a site was eventually selected at Leongatha, on a portion of the land which has been reserved for the Labour Colony. This locality is considered to be specially suitable, the soil being well adapted for cultivation, while the site also affords other advantages. The new farm is distant about half-a-mile from the Leongatha railway station, and, consequently, is easy of access to visitors. One of the objections to the Dunolly farm was its great distance from Melbourne, and consequently the difficulty of access to visitors requiring information and desirous of seeing how the operations were being carried on.

The Leongatha farm is situated on a portion of the reserve held by the trustees of the Labour Colony. These gentlemen, on learning that it was proposed to establish an experimental farm in the locality, promptly communicated with the Department of Agriculture, and offered to hand over as much of the reserve as was required for the purpose. Some difficulty, however, arose in getting permission from the Department of Lands to occupy, and a considerable time elapsed before this was granted. The season was then so far advanced that planting operations were seriously retarded, and it was found to be impossible to plant out so extensively as was intended. However, notwithstanding this drawback, several large plots were formed and planted with what were considered to be the most desirable kinds, and smaller plantations were made of others. The area planted is as follows :—

Two acres of lavender vera.
One acre of roses.
One acre of geranium, Africa.
One acre of mixed plants.
Half-an-acre of peppermint.
A small plot of ramie.
Also a nursery for raising plants of various kinds.

The land being held by the trustees of the Labour Colony, Colonel Goldstein, the honorary superintendent, very kindly undertook to get as much land cleared as was required, with the labour of the men who were obtaining relief as unemployed. The main portion of the other necessary work has been done with the same class of labour, under the direction and supervision of Mr. Burns. Special arrangements were made with Colonel Goldstein and myself as to the remuneration these men were to receive for the work of planting and cultivating, and this agreement is still being acted upon. I consider it to be my duty to state that everything possible has been done by those in charge of the Labour Colony to facilitate the work of starting the farm. In fact, without this assistance, operations would have been materially retarded, and it would have been simply impossible to have saved many of the plants that were shifted from Dunolly. Through the help that I received from the authorities of the Labour Colony, the losses were small, notwithstanding that the planting season was far advanced.

Cheltenham Experimental Scent Farm.

In 1898 I received instructions to report upon and deal with an application from residents of the Cheltenham district for the establishment of a Government farm for the experimental culture of scent-yielding plants. After careful consideration, the request was approved, as it was deemed advisable to encourage the trial of new industries by small cultivators. In consequence of this decision, arrangements were made with Mr. Hunt, a resident of the district, for the use of an acre of ground, as also to plant and cultivate it, to the satisfaction of the Department. These arrangements were duly carried out, the place was properly cultivated, and most of the plants have done well, but the result has been disappointing, as no persons have taken any interest in the operations. Though a still for treating the plants was sent from Dunolly, in charge of Mr. Burns, to show how the products are extracted, yet but little public interest was taken in the experiments. The results obtained, however, have proved that various scent-yielding plants can be grown to perfection in the locality, and that their products are excellent in quality. This establishment has now been carried on for upwards of two years, but as the results have not been satisfactory, I have received orders to close it, and this will be done as soon as the current season's crops are removed.

The Distribution of Cuttings.

The distribution of cuttings has been a work of some importance at the Dunolly Scent Farm, and considerable quantities have been sent away every year. The practice that has been adopted in supplying cuttings is to make a charge when applications are made for large quantities. When, however, small quantities are applied for, to be used for experimental purposes, the distribution is free from cost. Cuttings of perfume and essential oil yielding plants have been asked for by 72 applicants, and the number distributed is about 12,000. A large number of cuttings were also sent to the new farm at Leongatha, with the view of raising plants in nursery beds. Unfortunately, however, these cuttings were planted too late in the season, owing, as previously stated, to the great delay in getting possession of the land. Consequently these cuttings have not done so well as could be desired, and a large number have failed. The demand for white mulberry cuttings during the past year has been extensive, and in addition to 16,000 sent to Leongatha, 19,880 have been distributed among 598 applicants.

Insecticide Plants.

As insecticide powders and extracts are used to a considerable extent, it was considered advisable, when the bonus regulations were framed, to encourage, by every practicable means, the cultivation of plants from which these commodities are made. Therefore a bonus of £2 per acre was offered for the cultivation of these plants, and a list of those suited for the purpose was published. It was also decided to offer a bonus of £40 per ton for the prepared powder, in order to encourage its manufacture in a large way. Representations were, however, afterwards made that a ton was too large a quantity of such an article for an ordinary factory to produce, and the regulation was modified by making the bonus £2 per hundredweight. It was reasonably assumed that this industry would have attracted a good deal of attention, but this anticipation has not been realized. The responses to the bonus offers have been very few in number, and the results obtained, with a single exception, have been of no practical value. In fact, only two or three persons have attempted to cultivate insecticide plants for commercial purposes, though they are frequently to be met with growing in gardens. The amount paid as bonuses was £35, the whole sum going to one claimant.

Seeds of the two plants most generally used in the preparation of insect powder were widely distributed by the Department of Agriculture, and they were found to thrive in many parts of the colony.

These plants are Chrysanthemum (Pyrethrum) cinerariafolium, from which the Dalmatian insect powder is obtained, and Chrysanthemum (Pyrethrum) roseum, which is the source of the famous Persian insect powder. The most successful cultivator, and I may state the only one, is Mr. Keysattle, formerly of Traralgon, who is a chemist by profession, and has some knowledge of the business of preparing insecticides. This gentleman received the whole of the sum (£35) paid for the cultivation of these plants under the bonus regulations.

Mr. Keysattle commenced in a small way with the Persian species, but he found that the powder he obtained from it was greatly inferior in quality to the imported article. Having in his possession a few plants of the Dalmatian species, he tried these, and obtained an excellent powder, quite equal in quality to the imported commodity. This result induced him to plant several acres of the last-named species, and to obtain a small mill for reducing the flowers to powder. The larger area of crop gave results equally satisfactory to those obtained at the first trial—an excellent powder being secured, which was sold at a good price. I tested this powder myself and found it quite equal, if not superior, to the imported article. I must, however, mention that this cultivator had certain advantages that do not fall to the lot of ordinary growers. He was not only the grower of the plants and the maker of the powder, but, in addition, his regular business gave him facilities for selling it retail to the public. The experience of others who have tried this and other special industries is that the wholesale dealers are opposed to Australian productions as unreliable novelties, no matter what their real qualities may be.

In my opinion, the cultivation of insecticide plants is deserving of much greater attention than it now receives. The two species of Chrysanthemum mentioned by name are of a hardy nature, and thrive well in many localities, but more especially in Gippsland. They are prolific, very easily cultivated, and the work of collecting the flowers affords light and congenial employment for women and children, and other persons who are incapable of doing heavy laborious work. The powder is now extensively and generally used

for freeing domestic animals from vermin. It is also of great service in orchards and gardens, in keeping down certain troublesome insect pests. In America, more especially, it is used for the last-named purpose, but Australian cultivators are also becoming alive to its value. Liquid extract has of late come into use to some extent in place of powder, it being equally effective as an insecticide, while it affords advantages in other respects. I may state that I have obtained the extract from Victorian-grown plants, and found that it contained all the essential properties that are required. There is certainly a wide field open for this industry in the future. The main drawback to its progress at present is the apathy and even the opposition of the wholesale firms, who, to a large extent, control the trade in insecticides and other drugs and chemicals. I am, however, of opinion that these trade prejudices will be overcome by time and perseverance in proving that colonial products are quite equal in value to others.

Crops of the plants named will give satisfactory returns till the plantations are five years old. After they reach that age, it will be advisable to replace them with new plantations. The essential properties are contained chiefly in the flowers, which are gathered by hand strippers. After stripping, the flowers are dried and ground into a fine powder, which forms the commercial insecticide. Sometimes, when old plantations are being destroyed, the whole crop, including the flowers, leaves, and branches, is cut low down, dried, and ground up for powder. In the preparation of the material, as a matter of course, a mill is required for reducing the flowers to powder, but, as a small and inexpensive one will suffice, this will not entail much expenditure. It is a question, however, whether the Department of Agriculture might not with advantage assist those desirous of trying this industry in a small way by importing a mill for the treatment of the flowers under certain conditions.

Medicinal Plants.

Though a large number of drug-yielding plants are included in the list of those for which bonuses are offered under the regulations, yet the response from cultivators has been a very poor one. But very few people have been induced to give attention to this industry, and though a small number of applications have been made for the bonus allowances, yet,

I regret to state, the results obtained are of no practical value from a commercial point of view. That more attention has not been paid to the cultivation of this large and important class of plants is to be regretted, as their products are extensively and generally used, and consequently they are in great demand. The numerous plants included in the list published with the bonus regulations, may all be grown successfully in many parts of the colony, and most of them are easily cultivated. The great drawback to this industry is doubtless the difficulty in selling the products in the colony after they are obtained from the plants. Wholesale druggists in Melbourne have hitherto not been particularly anxious to purchase colonial products, and, when they do buy, it is generally at prices far below the real value of the commodity. Possibly, in time, druggists will appreciate to a greater extent than at present the true value of the products of medicinal plants grown in the colony, and then cultivators will have greater encouragement. In the meantime, however, the main hope for cultivators is the development of an export trade to Europe, which affords a good market for drugs, as well as other products, provided they come up to a high standard in quality.

Tanning Plants.

In the Australian colonies the importance of this class of plants seems to be very much under-estimated, judging from the small attention their cultivation has hitherto received. Doubtless this apathy is in some measure attributable to the widely dispersed growth of our native wattle trees, whose bark is so extensively used for tanning leather. But though wattle-bark is a valuable commodity, yet we must bear in mind that it is not the only tanning material required in the production of leather. Other tanning substances are wanted, and some of these are in extensive demand. Various kinds of leather are produced with different kinds of tanning material, and the plants that yield these are worthy of attention in localities where they are likely to thrive.

Wattle-bark has always been an important colonial product, as there is a large local demand, and of late years a considerable export trade has been developed. A large proportion of the bark used is obtained from trees of natural growth, though, of late years, considerable quantities are procured from plantations that have been made.

This latter method of raising wattles seems to be growing in favour, and considerable areas are now devoted to systematic cultivation of these trees.

Among other tanning plants the one that has received the most attention in Victoria is canaigre, a species of the "Dock" family, known scientifically as Rumex hymenosepelas. It is a plant indigenous to Texas and Mexico, and has of late years been largely used for tanning purposes. This plant was introduced to this colony a few years ago with a high character, and consequently a number of settlers were induced to test its value. A company was also formed in Melbourne for growing this plant upon an extensive scale, and preparing the product for the tanning trade. Unfortunately, however, this company was not successful in its efforts, owing chiefly, in my opinion, to the selection of an unsuitable locality in Gippsland for carrying on their operations. Other cultivators in various localities obtained widely differing results, some getting excellent crops, while others only had medium or poor ones. According to my experience, this plant thrives best in the northern districts, where I have seen some really good crops. At Mildura I found the canaigre plant to be quite at home, and one crop that I inspected was estimated to yield 10 tons per acre. On the other hand, I have no hesitation in saying that Gippsland is quite unsuitable for the cultivation of canaigre.

Probably the cultivation of this plant would have made progress had there been a local demand for the product, but this does not exist, except to a very limited extent. Consequently, there has been no inducement to cultivate this crop when others promised more certain returns. As with most other commercial plants, canaigre requires the opening up of an export market to make it a remunerative crop. This, however, will doubtless be obtained sooner or later, as the tanning material obtained from this plant is extensively used in Europe and America, and the supply from natural sources is said to be limited. Crops when grown under favorable conditions yield a large bulk of roots, which contain about the same proportion of tannic acid as wattle-bark. The roots can be sent to market when sliced and dried, and in that form the material is sufficiently valuable to yield good profit to the cultivator after all charges are paid. The product can also be exported in the concentrated form of an extract, and possibly this method may prove

more advantageous than shipping the roots. Though hitherto the cultivation of canaigre has certainly not proved a satisfactory industry, yet I believe there is a better future before it, and that the plant is deserving of more attention than it now receives.

Sumach is a valuable tanning material that might be evtensively produced in Victoria with advantage to the cultivators. It is mainly produced from a small tree, known botanically as Rhus coriaria, whose leaves, when dried and reduced to powder, form the commercial article. Several other species of the Rhus family also yield sumach, though their leaves are not so rich in tannic acid. Various species are grown in Victoria as ornamental plants, and they thrive well in many localities, but more particularly in the northern districts. They have not, as yet, received attention for their products, though the growing of sumach is worthy of attention as a promising industry. The species mentioned by name, which is commonly known as the "Tanner's sumach," is a very thrifty tree, aud when grown under favorable conditions yields large crops of leaves, which are remarkably rich in tannic acid, yielding as much as 30 per cent. The cultivation of sumach is simple, plantations being formed from small sets placed in furrows made by the plough, and covered by the same means. When growth commences, the shoots ascend and form a mass similar to the osier willows, and these are removed annually. The work of cutting can be performed either by hand or machinery. When cut, the shoots are tied up in bundles, stacked, and threshed to remove the leaves, which form the commercial article.

Valonia is another valuable tanning material which is in great and growing demand in Europe. It is obtained from a large growing tree belonging to the "Oak" family, and is commonly known as the "Valonia oak," and botanically as Quercus Ægilops. This tree was introduced to the colony some few years ago and planted at Castlemaine, where it has done remarkably well. There is no doubt that it will succeed equally well in many other localities if fairly tried. Valonia is a substance obtained from the cups of the acorns which are freely produced. As a tree yielding a valuable tanning material that is in extensive demand, the valonia oak is well deserving of attention. There is a good market in Europe for valonia in unlimited quantities, and it is said that, of late years, the supplies from the usual

sources are not equal to the requirements of the tanning trade. The trees are also well worthy of being cultivated for ornamental and shade purposes. They are also useful for their acorns, which are excellent food for some domestic animals, who eat them with avidity. Cultivation is easy and simple, as, after planting, the trees require but little care except in keeping down weeds in the early stages of growth.

Osier Cultivation.

It is somewhat surprising that so little attention has been paid to the cultivation of osier willows in this colony, as there is a large and growing demand, which at present is mainly supplied by imported material. Several species of willows are suitable for the production of osiers, all of which have been proved to thrive in many parts of Victoria. Osier willows flourish on sandy loamy soils that keep fairly moist through the summer, and they are well suited for irrigated land and the banks of running streams. Under ordinary favorable conditions, a plantation of osiers will yield annually from 8 to 10 tons per acre. Plantations will yield a full crop in their third year, and will last for a long period. Cultivation is simple, and but little labour is required after planting, except keeping down weeds in the early stages of growth, and cutting the crops. As osiers will always be in large and steady demand for basket-making, I am of opinion that their cultivation is well deserving of attention from settlers who have land suitable for the purpose.

I may further remark that, as regards osier plantations, the value of the crops will depend in a large measure upon the system of cultivation that is practised. In order to obtain an annual growth of strong shoots, it is necessary to prune well back, so that the growth will not be too widely distributed. Too frequently, the plants are allowed to form high stems; as a consequence, the growth extends through numerous channels, and the shoots become weakly and poor. As an example, I may state that advice was asked for respecting the treatment of an old osier plantation at Pentridge. I was requested to deal with the matter, and upon inspection found that the plantation was a very old one, said to be over 40 years, the stems of the plants had been allowed to get too long, through the lack of knowledge as to their proper treatment. I recommended that the stems should be cut off near the surface of the soil, so as to form

new heads, and my advice was taken. The result of this treatment has been very satisfactory, as the portion (one-third) of the plantation that was cut back, has yielded a heavier crop than was previously obtained from the whole area.

Broom Corn.

The cultivation of broom corn may now be regarded as a very promising agricultural industry, and is consequently deserving of increased attention from farmers. Millet brooms are now made within the colony in large numbers, and a considerable quantity of material is required to fully supply the manufacturers. To meet this demand, large quantities of broom millet have hitherto been imported, chiefly from America, but a large portion has also been obtained from New South Wales. At present the annual importations amount to between seven and eight hundred tons. Though, for some years past, broom corn, in small quantities, has been grown in Victoria, yet this crop, until recently, seems to have found but little favour with farmers, as the area cultivated previous to last year was always limited. Probably the cultivation of this crop would have received more attention in the past, if encouragement had been offered by means of bonuses when that system was first initiated. Broom corn, however, was not included in the bonus list till recently. When this encouragement was given, the cultivation of this crop received a great impetus, and, as a result, last year applications for the bonus allowance were made for nearly 400 acres of broom corn.

Broom corn is one of the hardiest species of the Sorghum family, and can be grown successfully in various parts of the colony. It is admirably adapted for the rich alluvial soils of river and creek flats and reclaimed swamps. Land that can be irrigated is also specially well suited for the cultivation of this crop. Wherever maize can be grown successfully, this crop may be cultivated with certainty. When grown under favorable conditions, this crop will yield a considerable quantity of broom fibre per acre, but it is essential that the land must be good, and that the plants do not suffer while making their growth through lack of moisture in the soil. As a matter of course, when not grown on irrigated land, where the supply of moisture is under control of the grower, the results will, in a great measure, depend on the season. Cultivators, however, may do much towards mitigating the

ill effects of dry seasons by preparing the land well, keeping down weeds, and by good surface tilth during the growth of the crops.

The value of prepared broom fibre varies considerably, according to the quality of the material. A very large proportion of the fibre grown in the colony is inferior, from the broom manufacturers stand-point, owing to certain defects. The most common fault is a coarse central stem, which, if used, makes the brooms stiff and unpliable, which is undesirable. As showing the great differences in value, I may state that the prices given for the prepared article range from £18 to £50 per ton. In fact, even higher rates are sometimes paid for a specially good sample. These great variations in value show how necessary it is for growers to take special care to obtain crops of the highest quality. Seed should be selected exclusively from plants having the most desirable characteristics, and not from a promiscuous crop, as is too often the case. It is a well-known fact that broom corn, like all other cultivated plants, is apt to alter in character, or revert to its original type, and the quality of crops can only be kept up by the careful selection of seed.

Independent of the value of its fibrous heads, broom corn is well worth cultivating for its seeds. These are freely produced, and a good crop will yield from 30 to 40 bushels per acre. Seed has about the same feeding value as maize, and may be utilized for the same purposes. As a fodder plant the broom corn is also worthy of attention, as it yields a large bulk of most nutritious food for stock, when cut green, and it is also a useful crop for the silo. When grown for its broom fibre, this plant has also considerable value as a fodder crop, as, after the heads are removed, the stalks can be utilized to advantage for feeding stock. They have a good feeding value, and may be preserved till times of scarcity, when they will prove very useful as stock feed.

Various Minor Crops that should Receive Attention.

There are several plants, yielding products that are extensively and generally used, which have received but little attention from farmers, though they are not more difficult to grow than ordinary cereal crops, and will thrive in most parts of Victoria. Prominent among these plants is canary grass, the seed of which is so largely used as food for small

cage birds. This crop can be grown wherever wheat or barley will thrive, and its cultivation is equally simple. The plant is prolific, and, under ordinary favorable conditions, will yield crops of from 20 to 25 bushels per acre. Though a large quantity of seed is used in the colony, nearly the whole of it is imported. This crop is certainly deserving of attention, as a considerable quantity of seed could be absorbed by the local market, and the surplus will always find a market in England. Canary grass is also well worthy of cultivation as a fodder crop, as it makes very nutritious hay and yields a large bulk.

Another useful commercial plant is the caraway, which is quite ignored by farmers in this part of the world, though it is one of those special crops that are particularly deserving of attention. There is a moderate demand for the seed in the colony, as it is used for various purposes, but the entire supply comes from outside sources. The local demand should be easily supplied by Victorian-grown seed, and any quantity of this can find profitable markets in Europe. I may remark that, in Europe, the seed is in great request for producing an essential oil, which is extensively used in flavouring perfumes and soaps. The caraway is a hardy, thrifty plant, and may be grown successfully in almost any soil or locality. Crops growing under favorable conditions will give returns of from 20 to 30 bushels per acre.

Closely allied to the last-named plant is coriander, which probably would be found a payable crop if fairly tried. The seed is used for the same purposes as that of the caraway, and is in considerable demand in Europe. The essential oil, however, differs from that of the caraway in some respects, having peculiar and distinct properties. It is largely used for flavouring condiments, perfumes, and soaps. As the plant is hardy, thrifty, and prolific, it is worthy of some attention.

Lecturing.

This important work, I regret to say, has latterly not received so much attention as could be desired, owing to the many demands for my services in other directions. In order to stimulate the various agricultural industries which are suitable for the colony, the principal requirement, in my opinion, is to afford settlers the necessary information regarding the cultivation of special and general crops, and the

methods of preparing the products for market. One of the most effective ways of doing this is by means of lectures in the different districts, and inviting inquiries from those who attend, as regards the subjects dealt with. Experience has proved that the desire for this kind of information is widely felt, and, during the period I have been connected with the Department, this method of instruction has always received my close attention, whenever time was available for the purpose. In giving my lectures, I endeavour to make them as practically useful as possible by illustrating, in various ways, the subjects dealt with.

In lecturing, the system I have adopted is to visit a district, and in the day-time exhibit the various products, or other articles, that may be required to illustrate the particular subject treated. In the evenings, the subject is further dealt with, and, as far as may be practicable, illustrations are given with the aid of the lime light. Further information is afforded by answering questions relating to the subject discussed, and these are always specially invited. When on these lecturing visits, I also make it a practice, if requested, to go to the farms of those who may be desirous of trying the cultivation of special crops, and give any necessary information.

As a result of my lectures and visits to farms, many settlers have been induced to enter upon the cultivation of special crops in an experimental way. For the want, however, of further necessary information, most of these settlers have not been able to get beyond the experimental stages. It is essential that the educational work commenced by means of lectures and advisory visits to farms and orchards should be continued regularly, and not spasmodically, as is now the case. In order to make my lectures as practically useful as possible, I have prepared and exhibit illustrations of the following subjects, namely :—

Perfume plants,
Fibres and oils,
Broom corn,
Grasses,
Fruit cultivation,
Fruit drying and pulping,
Cider making,
Poultry.

Other Special Products.

These subjects have all been dealt with, from time to time, in various districts, but latterly the press of other work has, to a large extent, prevented me from giving lectures.

Exhibiting at Country Shows.

During the past year, collections of special and general products have been exhibited by the Department, at various country agricultural shows, for educational purposes. This work has been attended to principally by Mr. Robilliard. As an effective means for disseminating practically useful information, this class of exhibits appears to be highly appreciated by many, judging from the numerous inquiries made respecting them. There can be no doubt, in my opinion, as to the educational value of these displays, which afford object lessons that are more impressive to many than they can obtain by any other means. These exhibits afford strong evidence to those anxious for information that satisfactory results in raising certain products have been obtained, and that the way is open for others to follow. Inquirers are also, by means of these exhibits, able to ascertain, to a large extent, what special products are most suitable for their districts.

The collections exhibited are extensive and varied, including both raw and prepared products, the latter either wholly or partially manufactured, as also specimens of the plants from which they are obtained. Included in the list are fixed and essential oils, fibres of various kinds in different stages of preparation, insecticide plants and their products, tanning plants, broom corn, also various other plants and their products, that may be cultivated in the colony.

Owing to the great interest that is taken in these exhibits, wherever they are displayed, I am induced to strongly recommend that the practice of attending country shows should be extended as far as may be practicable. If, however, the system is extended in the way I propose, it will be necessary that the various agricultural societies should make better arrangements for fixing the dates of different shows, so that there will be less clashing than prevails now. Under the existing state of affairs several shows are often held on the

same day, and it is impossible for all of them to receive attention. The system hitherto adopted by the Department has been to deal with applications as they are received, and, consequently, important shows have frequently to be passed over, because requests have previously been accepted from others, that are of less importance, which are held on the same dates. Better arrangements are certainly necessary, if exhibiting at country shows is to be extended, and probably a circular from the Department, notifying the various societies to that effect, might prove serviceable.

Collecting Exhibits for England.

When it was decided to send collections of our agricultural and horticultural products to England, for the Greater Britain Exhibition, and also for Mr. Sinclair, London general agent for the colony, I was instructed to obtain such various samples as were required. The work of collecting these occupied a considerable portion of my time during the early part of the past year, and the latter portion of the preceding one. I took the greatest care to obtain the best possible collections, and these were duly sent to their destinations. Both collections, as I am informed, attracted a considerable amount of attention in England, and have induced many inquiries as to the agricultural resources of Victoria. The collection for the Greater Britain Exhibition answered its purpose, namely, a display lasting for a few months only. As regards the collection for the London office of Mr. Sinclair, the conditions are different, as a permanent display is required. A large portion of the exhibits being of a perishable nature, they have, as a matter of course, to be replaced from time to time, with fresh ones, in order to keep the collection as it ought to be. I have been requested to obtain such exhibits as may be required for the purpose, and have made the necessary arrangements to do so.

I may remark, however, that if a representative display of Victorian agricultural and horticultural products is to be continued permanently in London, renewals must be made frequently. In order to secure the most desirable samples, a more systematic way of collecting the exhibits should also be adopted by the Department. The best samples of Victorian products should always be available for the purpose, and these can only be obtained by a careful system of selection.

I may also suggest that there are various exhibits which might be included in the London collection in charge of Mr. Sinclair, which would make it more interesting and instructive.

Prominent among the proposed additions are samples of the soils found in various parts of the colony, with analyses showing their composition and such further information as may be desirable. Through these exhibits and others, much would be done in the way of educating those who are desirous of obtaining information respecting the agricultural capabilities of Victoria. I may further state that the cost of collecting and preparing these additional exhibits would necessitate but a comparatively small outlay, which would be money well spent.

Experimental Farms.

Various experiments have been made from time to time by settlers in different parts of the colony with seeds supplied by the Department of Agriculture, but though in a few cases useful information has been gained by this means, yet, speaking generally, the results have not been so satisfactory as could be desired. This system of making experiments is necessarily of little value to the agricultural community, as settlers are under no obligation to cultivate methodically; to make the requisite observations as regards the crops; or to supply to the public any information that they may require. Carefully made experiments in the cultivation of various crops are essential to the progress of agriculture, and this kind of work should be encouraged as much as possible. What is required is that experiments should be carried on upon a wider and more certain basis than if left to individual efforts, with no responsibility. I am of opinion that this desirable object can be attained, in a large measure, by making special arrangements with progressive farmers in various districts, to carry out such experiments as may be arranged. A few acres on a farm would be a sufficiently large area, and, for a small sum annually, many settlers can be found who would be willing to find the land and the necessary labour. The experiments made on these farms would be under the direction, and to a large extent under the control, of the Department of Agriculture, and the results obtained available for public information. As a matter of course, arrangements would have to extend over a few years, as with some crops long periods must elapse before the results of experiments can be ascertained.

I am also of opinion that the Department of Agriculture should have under its sole control several small farms in various districts where experiments could be methodically made. Comparatively small areas, say from 10 to 20 acres, would be sufficient for the purpose. If live stock were kept, the areas would necessarily have to be larger. The cost of keeping up these farms would be comparatively small, as they could be placed in charge of intelligent agricultural labourers, who should do the necessary work under instructions. The work on both classes of farms should be directed by expert instructors, who would visit each frequently, to advise and see that the arrangements were carried out in a proper manner.

Inspection of Agricultural Exports.

Since I have been engaged in supervising the export of fodder to South Africa, on behalf of the Imperial Government, various circumstances have come under my notice, showing the necessity for a systematic inspection of all agricultural products intended for export. Shippers too frequently are somewhat careless as to the quality of the commodities exported, or the mode of packing, and, as a consequence, our products are in danger of getting a bad reputation in the United Kingdom and other countries. In order to develop a large and continuous export trade, it is essential that all produce sent away should be of high quality, and shipped under the most favorable conditions. These requirements will be most effectively provided for by a thorough system of inspection by well qualified persons. Though it may be true that the majority of shippers will, for their own credit, take all necessary care with their consignments, yet without systematic inspection their efforts to open up a trade may be neutralized by even one or two careless exporters. With a thorough inspection, it would be possible to supply reliable information to farmers and others as to the demand for agricultural products in other parts of the world, and where payable markets are likely to be found. Information should also be given as to the best way of shipping various kinds of products, so that consignments will arrive at their destinations in the best possible conditions. As examples, potatoes and onions might be exported to a much greater extent than at present, if they were packed to withstand long voyages. When treated in the

ordinary way, that is packed in bags and knocked about in railway trucks, and in ships' holds, with men trampling over them with heavily shod feet, the commodities are necessarily bruised to a great extent and decay soon commences. If packed in cases, and treated with ordinary care, the same as apples, there ought to be no difficulty in exporting them in good condition to South Africa, India, and even the United Kingdom. I am glad to know that exporters have already begun to turn their attention to improved methods of shipping potatoes and onions. I know of one firm who, during the current season, have shipped 100 tons of potatoes to India and South Africa in cases, and further consignments are to be made up to 1,000 tons.

Royal Park Experimental Farm.

Last year, at the request of the Silk Growers' Association, an area of land, 5 acres in extent, was fenced and planted by the Department of Agriculture with several varieties of the white mulberry and different kinds of perfume plants, with a view of testing their value commercially. Since the place was planted, I have visited it several times to see how things were going on, and I regret to say that they are not so satisfactory as could be desired. This result is due to the lack of the necessary skill and attention in carrying on the work of the place. I may further state that the condition of this plantation affords an example proving the desirability of the Department exercising a closer supervision over the Royal Park Experimental Farm and kindred establishments.

Answering Inquiries by Letter.

Numerous letters are sent to the Department of Agriculture, asking for advice upon matters relating to the bonus regulations. Many others are received with requests for advice as to the cultivation of various economic plants, and the preparation of their products as marketable commodities. Applications are frequently made by public institutions, and private persons, respecting the laying out of ground, making new plantations, and also the renovation of orchards and other trees that have been badly cultivated through the lack of technical knowledge. These applications are mostly handed over to me to attend to, and I may

state that this work occupies a good deal of my time, as many letters have to be written in answer to the inquiries. In many cases, a written reply will not be sufficient, as I am unable to give the information required without making myself practically acquainted with certain local conditions. This entails visits to a good many places in various localities, and these take up a considerable portion of my time. I must also mention that, during the time I have been connected with the Department, I have written several handbooks on various subjects which afford practical cultural and other information, likely to prove serviceable to settlers. These handbooks and others have been issued by the Department under the title of "Guides to Growers." Further I may say that other books of the same class will be prepared by me, whenever time is available for the purpose.

REPORT BY THE VEGETABLE PATHOLOGIST.

(D. McAlpine.)

In accordance with your request for a detailed report of the work of the Pathologist's Branch for the year ending 31st December, 1899, I have much pleasure in furnishing same.

The work done has been of a varied character and greater interest is being taken in it by the growers themselves, as evidenced by the large number of diseased specimens forwarded, and the numerous requests for information. This activity is no doubt partly due to the educational influence of the Vegetation Diseases Act, and of the inspectors appointed under it. The consequence was that correspondence was largely increased, and no less than 1,137 letters were despatched during the past year.

The losses caused in the aggregate by fungus diseases are hardly realized. They act in such an insidious manner and are so often confounded with the effects of climatic and weather conditions, that they do not impress the average grower. It was estimated from reliable data that stinking smut alone cost the colony at least £50,000 in 1898, and this disease has been shown, by experiments on a comparatively large scale conducted in the mallee, at Longerenong Agricultural College, and Port Fairy, to be entirely preventible. The same applies to numerous other diseases recorded in this report, and prove, if proof were needed, that the modern grower must be prepared to recognise and combat his natural enemies, and be guided by the teachings of the saving science of vegetable pathology. He will also require to know something of the results of modern investigation, and not be so antiquated as the chairman of a branch of the Agricultural Bureau of South Australia, who stated, with reference to smut and bunt, "many attempts have been made to discover the cause, but as far as I have learned, every attempt has been unsuccessful."

Since it was found impossible to overtake the increased work single-handed, temporary assistance was granted me, and Mr. G. H. Robinson, of Ardmona, who had acted for some time in an honorary capacity, was appointed assistant for three months. His practical knowledge of fruit-growing

and fungi, his familiarity with the microscope, and his successful career as a student, both at Longerenong Agricultural College and the School of Horticulture, Burnley, well fitted him to render me efficient service.

To give a general idea of the work done, it will be found convenient to arrange the information under the following headings :—

I. Principal Diseases of the Year.
II. Entomogenous Fungi.
III. Experiments.
IV. Library.
V. Laboratory.
VI. Herbarium Specimens.
VII. Museum Specimens.
VIII. Publications.
IX. Miscellaneous.

I.—Principal Diseases of the Year.

The study of disease has become an absolute necessity if the grower is to secure the full benefit of his labours. It is all very well to say encourage healthy growth and follow natural methods, but the great majority of our cultivated plants are not native, and the imported stocks have probably brought disease with them. Man is thus an agent in the introduction of disease, but he is also able by his skill and knowledge to devise measures for its prevention.

To diagnose disease properly and apply remedies is no easy task. Before a diseased condition or the deviation from the normal life of the plant can be thoroughly understood, one must be familiar with the normal life functions, and thus physiology, or the study of healthy activities, lies at the root of pathology, or the study of disease.

The various disorders of plant life may be due to a variety of causes, and successful treatment will usually depend on this recognition of causes.

1. Diseases may be due to mechanical agencies, or soil conditions, such as various wounds and "wet feet."

2. Or to atmospheric conditions, such as frost and hail. The influence of climate upon vegetation is a complex one, and each succeeding year is worthy of special study in this respect. The liability to disease is largely influenced by it, and the vicissitudes of the weather during the past year and the drought of previous years, no doubt contributed much

to the diseased conditions prevalent, such as excessive gumming. The abundance of rain at one period, and the severe frosts at another, the sudden changes and low temperatures, would all tend to predispose, as it is called, to disease.

3. Diseases due to unknown or doubtful causes, such as the bark blotch of the apple and gumming. Numerous and serious cases of gumming were brought under my notice in a great variety of trees such as cherry and plum, peach and apricot, &c., and it was no easy task to account for it, especially when there are so many possible exciting causes. Of these may be mentioned—

(*a*) Due to a fungus, *Corynum beyerinckii*, Oude.
(*b*) Due to bacteria, which may start the injury.
(*c*) Due to galls at the root.
(*d*) Due to insect punctures.
(*e*) Due to atmospheric conditions such as frost, excessive rainfall, &c.
(*f*) Due to any unfavorable conditions reducing the vitality of the plant.
(*g*) Due indirectly to hard clay soil not properly drained.
(*h*) Due to transplanting in too strong soil, which has been assigned as a cause in the case of cherry trees.

Where instructions had been carried out to slit the bark, and thus allow the gum to escape before it had penetrated to the sap-wood and prevented the flow of food material, the trees did not seem to have suffered much.

4. Diseases due to animal organisms, including insects. While Mr. French, the Government entomologist attended to all the insect pests, I had brought under my notice the eel-worm (*Tylenchus devastatrix*, Kuehn.) attacking the onion, and the eel-worm (*Tylenchus scandens*, Schneid.) producing ear-cockles in wheat. The latter does not seem to be very widespread, at least in Victoria, and if pickling for smut is thoroughly done, skimming off all the smut balls, at the same time the ear-cockles would be removed.

5. Diseases due to fungi ; and that is the special division which belongs to me.

It will be seen, from the following incomplete list, that the principal economic plants grown on a commercial scale were all more or less attacked by some form of fungus disease, but numerous specimens found on native vegetation or weeds,

are not here recorded. The diseases of the peach and apricot will be dealt with in a special pamphlet, and the rusts of wheat, oats, and barley, will be fully considered in the special report on the experimental plots.

Apple.

Black Spot or Scab (*Fusicladium dendriticum*, Fckl.). This disease was pretty widespread and severe. It occurred on leaves and young shoots, as well as on fruits. The great advantage of persistent spraying was seen in those orchards where it was carried out.

Bark Blotch. This is an obscure disease which has been under observation for the last two years, and is still receiving attention. Dark swollen blotches occur upon the bark, and these increase each year, generally running together and ultimately causing the death of the tree. It is very prevalent in the Goulburn Valley, and is most commonly found on such varieties as Irish Peach, Jonathan, and Cox's Orange Pippin. The cause has not yet been determined—whether due to a parasitic fungus or to unfavorable conditions of soil and climate, heat and moisture. An analysis of the soil has been undertaken, and a careful microscopic examination of the diseased tissues will be made.

Eye Scab (*Sporodesmium cerebriforme*, n. sp.). This disease has been brought under my notice this year for the first time. The skin of the apple surrounding the eye or calyx end is of a greyish-brown colour, scab-like, and usually broken up into somewhat deep fissures. Here and there the minute flakes are black and easily detached. It causes much damage and disfigurement of the fruit, and occurs both early and late in the season. In April, Inspector Cock sent me specimens from the Bendigo district, and on 23rd December, Mr. W. J. Allan sent me some small green apples from New South Wales affected with the same disease.

Apricot.

Shot-hole of Leaf and Scab of Fruit. There has been a considerable amount of this disease where spraying was not carried out. It is so widespread, because its means of reproduction are so perfect, as I have met with at least five different modes. A full account with figures will shortly appear.

Barley.

Smut (*Ustilago hordei*, Jens.) has been met with, but where the seed was steeped in a bluestone solution no trace of the disease appeared.

Yellow Patches. These were very prevalent in the Warrnambool district, and in some instances the crop was not worth reaping. A preliminary report upon this disease has already been given, and a fungus producing similar effects in Europe has been found here, viz., *Leptosphaeria tritici*, Pass.

Cauliflower.

Club-root or Botch (*Plasmodiophora brassicae*, Wor.) was brought under my notice. The disease arises from the soil in which the spores are present, and this points to treatment of the diseased soil to destroy the germs. Burning diseased plants, rotation of crops, clean cultivation, and the destruction of weeds, especially of the crucifer family, and lime at the rate of 35 to 75 bushels per acre applied to the soil will prevent the disease.

Root-rot (*Phoma brassicae*, Thuem.). This disease occurred in cauliflowers grown in South Australia, and was confined to the roots, although the effects extended to stem and leaves. Diseased plants should be burnt, the soil well limed, and a rotation of crops should be followed.

Celery.

Leaf-rust (*Puccinia bullata*, Schroet.) This forms small brown pustules on the leaves, and may be checked by spraying.

Cherry.

Root-fungus. A white fungus at the root did considerable damage during the past season. There was no fructification found to indicate its exact nature. It was associated with gumming, which was probably induced by severe frosts.

Citrus spp.

A special illustrated hand-book to citrus diseases has been issued, to which the reader is referred. But I have appended twelve coloured plates showing the principal diseases to be guarded against, with brief explanatory notes.

Clover.

Rust (*Uromyces trifolii*, Hedw.) This has been found upon leaves, leaf-stalks, and stems, causing them to swell and become distorted.

Leaf-spot (*Pseudopeziza trifolii*, Fckl.) is easily recognised from the dark-brown spots, particularly on the upper surface of the leaves. It may occur at various seasons of the year, and I have seen it where every care and attention was bestowed upon the crop. Some regard it as of no consequence, because it does not seemingly do much damage at first; but, since it may infect the crop the following season, the injury increases and becomes intensified.

Leaf-blackening (*Phyllachora trifolii*, Fckl., with conidial stage known as *Polythrincium trifolii*, Kunz). Dark-brown to black scattered spots occur on lower surface of leaf, and they might readily be mistaken for the preceding on a superficial view. The conidial stage was found at Leongatha Labour Colony in May, also in December. The disease is worst in damp spots and in wet seasons. For all these diseases, burning the clover fields in the autumn or spring is recommended, as well as frequent cutting of the crop, to prevent the disease getting too much headway.

Fig.

Leaf-spot (*Phyllosticta sycophila*, Thuem). This disease does considerable damage to the leaves. The spots run together in large patches at the margins, which become shrivelled up and fall away, thus often causing large portions of the leaf to be destroyed. This injuriously affects the nutrition of the tree, and the immature figs fall off.

Flax.

Rust (*Melampsora lini*, Tul.). This disease is very common on the native flax (*Linum marginale*, Cunn.), and extends to the cultivated flax. I have even had it sent to me from the neighbourhood of wheat fields, as causing the rust there; but it is quite different.

Gooseberry.

Leaf-spot (*Phyllosticta grossulariæ*, Sacc.). This is a disease affecting the leaves, also known in Italy and North America. It produces spots, occupying most of the edge of

the leaves, of a grey to fawn or brownish colour, with definite raised margins. Towards the margin, large areas become blotched by spots running together, and the leaves soon fall, the plant exerting itself to produce fresh leaves.

Root-rot (*Armillaria mellea*, Vahl.). This is a disease which is exceedingly common, and very destructive to forest and orchard trees and shrubs. It is responsible for a great deal of damage, and what is often spoken of as natural decay and premature death is really traceable to this cause. Different fungi are responsible for rotting at the root, by means of an under-ground mycelium, and it is only, as a rule, when the fructification appears above ground, that the fungus can be definitely settled. So far, only two have been definitely proved in Australia to cause root-rot.

Raspberry-root fungus (*Hypholoma fasciculare*, Fries.) has been determined as the cause of the decay (see *Guides to Growers*, No. 32), and in the gooseberry the honey agaric is shown to be the root-destroyer. (See plates XIII. and XIV.)

Grape.

Oidium and anthracnose have been met with, but not to any great extent, and the Aureo grape-rot or scald, as it has been called (*Aureobasidium vitis*, V. and B.), was found on specimens sent from Tasmania. The "Noble Rot" (*Botrytis cinerea*, Pers.) was common in some districts in ripe berries. For full account and treatment of vine diseases, see "Additions to the Fungi on the Vine in Australia."

Grasses.

Various grasses were found with parasitic fungi upon them, but only two of these will be specially mentioned here.

Fairy ring Puff-ball (*Lycoperdon furfuraceum*, Schæff.). The so-called fairy rings in pastures are not at all uncommon in the old world, and they exist in Australia, but they are not generally regarded as of serious import. They were brought under my notice, however, on bowling-greens and lawns, where they spread so extensively and left such bare patches, that they threatened the destruction of the entire green in some instances. A full account of the fungus causing them and methods of treatment is given in my pamphlet, entitled "Fairy Rings and the Fairy Ring Puff-ball."

As might have been anticipated, from the nature of the fungus causing them, and its transport by birds men, &c.,

the disease spread to various bowling-greens in the suburbs of Melbourne, but where the sulphate of iron remedy was properly applied, the fairy rings disappeared.

Grass-destroying Fungus (*Isaria graminiperda*, Berk. and F. v. M.). This is a fungus sometimes found growing in patches all over paddocks, and which destroys native as well as imported grasses. In one case, brought under my notice, it covered a tract of country about 10 miles in extent, and it seems to have been very prevalent this season, for I had specimens from Ballarat, Bacchus Marsh, and elsewhere. Probably the causes which contributed to the luxuriant growth of the grass also favoured the spread of the fungus. As far back as 1873, it was noticed in Departmental publications (Report of the Secretary for Agriculture, Victoria, 1873) as a new disease among rye-grass, and very prevalent in the Ballarat district.

It is easily recognised from its bright, coral-pink colour, and fleshy consistency, covering the grass with little branching tufts, sometimes half-an-inch high, like so many minute pink sea-weeds. Its gelatinous nature might suggest excess of moisture or bad drainage, but, as a matter of fact, it is said to be generally found on the high and naturally-drained portions of paddocks. Various experiments have been tried to prevent it, based upon the fact of its being a fungus disease, such as the application of common salt and flowers of sulphur, but without satisfactory results. In the Report already referred to, it is stated that "without the cause which produces the disease, and the conditions under which it is developed, having been carefully determined, it is difficult to suggest any remedial measures."

Although more than a quarter of a century has elapsed since that was written, I am not aware that we have any further knowledge on the subject to-day.

Like so many other fungus diseases, its life-history awaits investigation—how and when it reproduces itself, how and where it passes the winter or other resting stage, and the conditions favorable or unfavorable to its development, in order that some rational treatment, based upon a thorough knowledge of the cause, may be applied to it. If we knew more of its history, it might be possible to suggest a time for burning off the diseased patches, in order that the fungus might be destroyed before it had produced its spores for next season's growth. It seems that where manure is spread it does not occur.

Lemon.

The *Illustrated Handbook to Citrus Diseases and their Treatment* gives all necessary information.

Lettuce.

Shot-hole (*Fusarium lactucæ*, n. sp.). This disease occurs both in South Australia and Victoria, causing numerous pale brown spots and patches on leaves, which ultimately become holes. These holes first show singly, then increase in number until the leaves are riddled. The lettuces are attacked at all stages of growth, but not so severely in the early part of the season.

Lucerne.

Leaf-spot (*Pseudopeziza medicaginis*, Sacc.). The disease is similar to that on the clover.

Leaf-blackening (*Polythrincium trifolii*, Kunz.) is caused by the same fungus as on clover.

Maize.

Smut (*Ustilago maydis*, Corda). Badly-smutted heads were sent to me from New South Wales, and probably it exists in Victoria, although I have not seen it, for it generally occurs wherever maize is cultivated. Fresh manure should be avoided, since the smut is most prevalent under these conditions. It is recognised in the United States pharmacopœia, as it resembles Ergot in its action.

Mulberry.

Bacteriosis (*Bacterium mori*, Boyer). Several specimens of this disease have been sent to me during the year, and it seems to be spreading. In the affected branches, the tissue is discoloured, and the tips become withered, which is a sign of the disease, even in the winter. The leaves have large brown or black blotches on both surfaces, and, if these blotches on the under surface are examined fresh, a brownish slimy material is seen to project slightly from the cavity, and to consist of a moving mass of bacteria.

The best results were obtained by cutting well back, in the winter, every branch the tips of which were withered.

Anthracnose (*Phoma mororum*, Sacc.). The bark of the shoots becomes dark-brownish to blackish, and splits. Both black and white mulberry trees are dying off from this disease. It was first observed by Saccardo, in Italy, in 1884, on the white mulberry.

Nectarines.

Green fruit was sent to me from New South Wales, with blister-like swellings closely resembling the blister on the leaf, but the fructification of the fungus was not found. The fungus of leaf-curl (*Exoascus deformans*, Fckl.) also attacks young shoots.

Oats.

Loose smut (*Ustilago avenæ*, Jens.) and rust have both been met with.

There is a very common appearance in oats which is usually attributed to bacteria. The leaves assume a rusty-red colour, and is commonly spoken of here as "foxiness," or foxy oats. Whilst investigating the "yellow patches" in barley I found the same fungus (*Leptosphæria tritici*) on foxy oats, and its connexion with that disease will be further investigated.

Orange.

See *Illustrated Handbook of Citrus Diseases and their Treatment.*

Pea.

Spot (*Ascochyta pisi*, Lib.) has been rather common this year, occurring on all parts of the plant above ground (stem, leaves, and fruit). Burning diseased plants, liming the soil, changing the crop, and spraying with Bordeaux mixture early in the season, was recommended. It was very severe in the suburbs of Melbourne and at Port Fairy.

Pea mould (*Peronospora viciæ*, Berk.) was not particularly bad this season, but in previous years it has been very destructive in the Drysdale district. It belongs to the same genus as the dreaded potato disease.

Peach.

Rust (*Puccinia pruni*, Pers.) generally occurs on the under surface of the leaf, but I have also met with it on the stem and fruit. The disease is sometimes called "Peach Yellows" from the discoloured yellow spots on the upper surface of the leaf produced by the fungus, but it has no connexion with that disease, and, moreover, is amenable to treatment.

"Shot-hole" has been more or less prevalent.

Freckle (*Cladosporium carpophilum*, Thuem.)—This disease is known as "scab" in the United States, because it somewhat resembles the scab of the apple due to *Fusicladium*, but the name of freckle is so expressive that I have adopted

it in preference to others. It has not yet been met with in Victorian orchards, but it is common enough on peaches imported from Sydney, and so it has been proclaimed, in order to prevent its introduction here.

Leaf-curl (*Exoascus deformans*, Fckl.) has been very common this year in such orchards as neglect spraying. Like so many other fungus diseases, this one is much influenced by the character of the season. If a genial spring allows the foliage to mature properly and attain its full growth without a check, then the disease is kept in abeyance, but if a favorable start is followed by a sudden fall in temperature, then the fungus is able to spread rapidly in the tissues, while the growth of the leaf is checked. A knowledge of the nature of the fungus comes in here to help us in our treatment. Unfortunately our so-called practical men ignore the fungus, and are consequently helpless in dealing with the disease, consoling themselves with the saying, "What can't be cured must be endured." But the disease has been, and can be, prevented, as shown by numerous experiments both in the United States and among ourselves, which will be more fully referred to in the pamphlet specially dealing with the diseases of the peach, &c.

The fungus not only "curls" the leaves, but distorts and swells the young shoots, owing to the mycelium being perennial there and passing each season into the leaf buds. From the nature and life-history of the fungus the following measures are recommended :—

1. Destroy all diseased fallen leaves, since they carry the fungus over to next season.
2. All branches attacked by the disease should be pruned well back, so as to get rid of the perennial mycelium which always extends into next season's growth.
3. Spray with Bordeaux mixture (4 lbs. copper sulphate, 4 lbs quicklime, 50 gallons water); or copper sulphate solution (4 lbs. copper sulphate to 50 gallons water), just before the blossoms open, and again—if the season has been favorable to the spread of the fungus—just after the calyx drops from the fruit, with Bordeaux mixture of half the strength. It is worthy of note that, in some instances, where whitewash was used to retard the blossoming, there was a marked diminution of leaf-curl on such trees.

Pear.

Black-spot or Scab (*Fusicladium pirinum*, Fckl.) in some cases was very bad on the leaves, and distorted the fruit considerably.

Plum.

Rust (*Puccinia pruni*, Pers.) was not met with in great abundance.

Shot-hole (*Phyllosticta prunicola*, Sacc). This disease was pretty general on plum leaves in certain districts this season.

Potato.

Early Blight (*Alternaria solani*, Sorauer). This fungus occurs on both surfaces of leaves, causing them finally to become brown and shrivelled up. Also on the green stems, which ultimately decay from want of nourishment. The tubers are arrested in their growth, and only reach the size of marbles. The thorough application of Bordeaux mixture, before the disease has gone too far, will keep it in check.

Raspberry.

Root-rot (*Hypholoma fasciculare*, Fries.), was found attacking the raspberries this season. The disease is fully treated in *Guides to Growers*, No. 32.

Strawberry.

Powdery Mildew (*Sphaerotheca castagnei*, Lev.) occurred on the fruit and shoots. Same fungus also attacks the hop and various other plants. The disease was recognised in time, and dusting with sulphur saved the crop.

Leaf-spot (*Sphaerella fragariæ*, Tul.). This disease is very common, and I have often drawn attention to it. It may be checked by Bordeaux mixture, and burning-off is recommended. Professor Trelease, of the United States, notes :—"The most convenient way of effecting this is by mowing badly-rusted beds soon after the fruit is gathered, covering the dry tops with a light coating of straw, or harrowing up the old mulching, and burning them. This may seem harsh treatment for the plants, but it has been resorted to by many berry-growers, for the destruction of insects, with most satisfactory results, and every one who has tried burning over a strawberry bed, has been surprised by the vigorous and healthy appearance of the new foliage which soon unfolds."

Tobacco.

Mildew or Mould (*Peronospora hyoscyami*, De Bary). This disease is very destructive to the tobacco crop, but this season there has been very little of it. A series of experimental plots were laid out at the Government Tobacco Farm at Edi, and duplicated at Mr. Temple Smith's plantation in the same district, to test the efficacy of bluestone solution and Bordeaux mixture, but the absence of the mould prevented any comparative results being obtained. These experiments will be continued at least for three years. The same fungus was found by Mr. C. C. Brittlebank on leaves of native tobacco (*Nicotiana suaveolens*) growing near Myrniong, and as this plant is generally distributed, it might readily spread the disease.

Septoria tabacina (n. sp.) was found by Mr. C. French, jun., on native tobacco in the mallee in October, and I found considerable injury being done to the tree tobacco (*Nicotiana glauca*) at Swan Hill in the same month by *Ascochyta arida* (n. sp.).

Farlow has found the mould of tobacco on *Nicotiana glauca* in California, but it has not come under my notice yet in Australia.

Tomato.

Black-rot (*Macrosporium tomato*, Cooke). This disease was found on the fruit, but is likewise often present on stem and leaves.

Damping-off (*Pythium de Baryanum*, Hesse). This fungus occurred on the stems of young plants from South Australia, and caused them to topple over.

Withering of Leaf (*Cladosporium solani*, n. sp.). This fungus is very destructive to the leaves, causing them to become dark-brown and shrivelled, but it has not yet attacked the fruit. Only from South Australia.

Bacteriosis.

Tomatoes have been sent to me from various districts with a very characteristic appearance. They arrive at full maturity, but the blossom end is flattened, and instead of having the ordinary healthy skin, it is of a pale olive tint finally. The discoloured skin is firm, smooth, and glossy, but it is sharply marked off from the red skin and usually covers the entire upper surface. On cutting the tomato

lengthwise, the firm healthy part is seen to be distinct from the diseased part, the latter being more watery and of a dark olive-green colour. A slimy matter exudes, and is found to consist of myriads of swarming bacteria. Bacteria are so universally present, that great care has to be exercised and infection experiments carried out, before they can be definitely stated to cause disease; but, in this case, the slimy matter, consisting of bacteria, was so widespread that, in the absence of any other evident cause, they may be regarded as the authors of the mischief until infection is tried.

The principal measures to be adopted are :—

1. To destroy all diseased fruit, as soon as the discolouration appears.
2. To change the crop.
3. To grow such varieties as are known in the district to be free from disease.

Wheat.

There has been a considerable amount of rust in some of the experimental plots at Port Fairy this season, so that they were cut for hay; but it has not been general. Stinking smut or bunt was not very prevalent this year.

Walnut.

Bacteriosis occurred on both leaves and fruit from several parts of the colony. The leaves have brownish irregular spots scattered over both surfaces, gradually destroying the tissues, and there are black depressed spots on the green fruit, often coalescing and forming large black blotches.

I have not hitherto been able to devote much attention to the diseases of the more ornamental plants, but nurserymen and others, who grow them for commercial purposes, are justified in expecting some information about them. Many of the diseases to which they are subject are capable of being effectually treated, and considerable loss would often be avoided if proper measures were taken.

Carnation.

Spot (*Septoria dianthi*, Desm.). This is a well-known disease appearing as greyish-brown spots, more or less circular, on leaves and stems, surrounded by a well-defined purple band. Remove diseased leaves and avoid overhead spraying. Potassium sulphide or "liver of sulphur" may be used as a spray at the rate of 1 oz. to 2 gallons of water, or Bordeaux mixture at intervals.

Rust (*Uromycis caryophyllinus*, Schroet.) is another common disease, easily recognised by the grey blister-like elevations on leaves and stem. These pustules ultimately burst, and the reddish-brown powder, consisting of spores, is seen on the surface.

Treatment as above.

Fairy-ring or Leaf-Mould (*Heterosporium echinulatum*, Cooke). The symptoms of the disease are well marked, and it is readily recognised without microscopic examination. Light-coloured spots of a puce tint appear on the leaves, leaf stalks, and sepals, and on these spots concentric rings of a dark-coloured fungus occur resembling miniature "fairy rings."

Treatment as above, and care should be taken not to water the foliage.

Cineraria.

Rust (*Aecidium cinerariae*, Rostr.). The cluster cups occur on both surfaces of leaf, running along veins, causing depressions on upper surface and swelling on the veins on under surface.

Mr. Cronin, inspector, who forwarded the specimen, writes —"The plants are grown under glass, and are generally very healthy. There are not many leaves so affected, owing to the care that is taken to cut out the spots as soon as noticed. The disease spreads rapidly if neglected, and completely spoils a plant by denuding it of foliage."

Hollyhock.

Rust (*Puccinia malvacearum*, Mont.) is a native of Chili, but is now generally distributed in Australia, wherever plants of the Mallow family are cultivated. The pustules occur on all parts of the plant above ground, and sometimes the leaves are literally studded with them.

Collecting and burning the diseased leaves checks the spread, and spraying with Bordeaux mixture prevents it.

Mignonette.

Leaf-blight (*Cercospora resedae*, Fekl.). This disease is not at all uncommon around Melbourne. It causes dry brownish spots on the leaves, and soon the whole leaf becomes dry and withered.

Dilute Bordeaux mixture is a preventive.

Orchid.

A new species of Agaric (*Hebeloma frenchii*, n. sp.) was discovered by Mr. C. French, junior, parasitic at the base of *Pterostylis paduncula*ta, R. Br., at Cheltenham, in August. A new species of white rust (*Cystopus bicolor*, n. sp.) had previously been found by Mr. Walter at Sandringham, on basal leaves, stem leaves, and bracts of *Pterostylis concinna*.

Rose.

A special paper would be required to do full justice to the various diseases of the rose, but I will just notice two or three of the more commonly occurring.

Mildew (*Sphaerotheca pannosa*, Lev.). This forms a delicate white powder on the foliage, young shoots, and flower-buds, and spreads rapidly by means of the innumerable reproductive bodies. Later in the season, the shoots and fruit may become enveloped in a dense felt of mycelium of a dingy yellow colour, which produces the fructification that is to tide the fungus over the winter. These two stages of the same fungus seemed so distinct that they were given different names—the summer stage is known as *Oidium leucoconium* Desm., and the winter stage as above.

Dusting with sulphur or spraying with potassium sulphide will check it. Badly diseased portions should be removed and burnt.

Leaf-blotch (*Actinonema rosae*, Lib.). Black radiating spots are produced on the leaves which prematurely fall. Diseased leaves and defoliated shoots should be removed and burnt, and spraying with Bordeaux mixture should be begun as soon as the buds open.

Rust (*Phragmidium subcorticatum*, Winter). This occurs on leaves and young shoots, usually causing distortion of the latter. There are three different forms of the fungus on the same plant; and the fallen leaves with the winter stage should all be collected in the autumn and burnt, in order to prevent its reappearance in the spring.

Before growth commences, spray with bluestone solution, at the rate of about 2 ounces of sulphate of copper to 3 gallons of water, and after the buds have expanded with a dilute solution of Bordeaux mixture.

Snapdragon.

Spot (*Septoria antirrhini*, Desm.). This disease appears to be most virulent towards the end of the flowering season. The plants become discoloured and the leaves are speckled, ultimately becoming dry and withered.

Violet.

Leaf-spot (*Phyllosticta violae*, Desm.). In this disease the leaves assume a sickly yellowish-green tint, the margins usually withering and shrivelling up. The entire leaf soon decays, and as the disease spreads rapidly all the plants growing together become more or less unsightly. It is a very destructive disease in the United States, and persistent spraying with dilute Bordeaux mixture keeps it in check.

II. Entomogenous Fungi.

Entomogenous Fungi, or fungi parasitic upon insects, are deserving of careful attention when they destroy the insect pests which prey upon our crops. The Coccus Tubercle (*Microcera coccophila*, Desm.) has been found parasitic on the scale of the orange in New South Wales, and in the United States it has been found preying upon the dreaded San José scale. A number of such parasitic fungi still await investigation, but two have been more or less carefully studied during the past year.

1. The Locust Fungus, imported from the Cape, has been determined as *Mucor racemosus*, Fres. This fungus grows as a saprophyte on organic substances, such as bread and potatoes, but it has been found as a parasite on plums, causing ripe rot. It is only in South Africa where it has hitherto been known to be entomogenous.

2. A fungus has been found destroying the caterpillars which attack the cereal crops both in Victoria and New South Wales. It would evidently be a boon if the fungus could be practically applied as an insecticide, and, by pitting nature against herself, stay the plague of caterpillars which

periodically do so much damage. The life-history is at present being fully wrought out, and I have provisionally named the fungus (*Entomophthora Australiana*).

III.—Experiment Plots.

A.—*Wheat Experiments at Port Fairy.*

The experiments carried out this season with cereals have been very varied in their character, consisting of variety tests of wheat, oats, and barley, the treatment of stinking smut, and the relative rust-resistance of different varieties. They have likewise been conducted in different districts, under varying conditions of soil, climate, and cultivation, and comprised such widely separated localities as Port Fairy and the Mallee, the Leongatha Labour Colony and the Longerenong Agricultural College. Attention will be confined in this report to wheat, and will deal with such important subjects as selection of seed, and variety tests in the mallee. It is hoped that the results obtained from the testing of different varieties may prove of immediate benefit to the farmer, for small samples of the most promising kinds are now available for distribution, and the varieties best suited to the varying conditions prevalent in the colony may thus be determined by the most reliable and trustworthy means, viz., small test plots.

Selection of Seed.

For a number of years a systematic course of plant-breeding has been carried out at Port Fairy, and the main reason for the choice of this district is that it is one of the best localities known for testing the liability of a variety to rust, or freedom from it. Never a season passes without its appearance, and after a few years' trial, the rust-resisting power of any variety is pretty well determined under the conditions existing there. Varieties have been tested here from most parts of the world, and a number of valuable cross-breeds have been obtained year after year from Mr. Farrer. Besides, the close attention necessary for the successful conducting of the experiments and the practical experience required for working out details, involves the services of a skilled farmer, and Mr. John Goldie is an enthusiast in the work.

Single Seed Plots.—A sample of seed which it is desired to test is sown in what is called the single seed plots. From 20 to 50 seeds of each variety are planted by hand in rows

18 inches apart, and 6 inches between each seed in the row. The resulting plants are carefully watched and their characteristics noted, special regard being paid to their early maturing, yielding, milling, grain-holding, and rust-resisting qualities, combined with strength of straw and toughness of flag.

The test for rust-resistance is a special feature of these plots, and determines largely their rejection or retention on that account. Examinations are specially made immediately after flowering and just before reaping, and it is not such a simple matter as it looks. Mr. Farrer had called attention to the fact as early as 1892, at the Rust Conference held in Adelaide, that there are two principal kinds of rust which attack the wheat crop—the so-called spring-rust, which is comparatively harmless, and the so called summer-rust, which does the damage—and the particular kind of rust is determined microscopically. The advantage of growing wheats at Port Fairy for this purpose was strikingly shown this season. Steinlee and Rerraf, two of Farrer's crosses, and both promising wheats, were grown alongside of each other in the field plots, and while Steinlee had as much as 75 per per cent. of rust on leaf, sheath, and stem, and the black rust common, Rerraf was practically clean; at most, only about 2 per cent., confined to the leaf. Mr. Farrer appreciates the results obtained here, for in his paper on "The Making and Improvement of Wheats for Australian Conditions," he says, "The principal cause, however, of my work with rust not being satisfactory is that the summer-rust, which at intervals does such serious damage to our crops, of late has so seldom attacked my wheats at Lambrigg. It is this circumstance which makes my progress with the solution of the rust problem to be so slow;" and the United States Department of Agriculture, in its "Bulletin on Cereal Rusts," by M. A. Carleton, refers to some of the work as follows :—"In Victoria, McAlpine tried a number of varieties sent to him by Eriksson from Sweden, and the results he obtained showed well the differences in susceptibility of the same variety to different rusts."

Selection of Seed.—When a variety is found to promise well, and possesses the necessary rust-resistance, it is selected for further trial. The best ears of the best plants are saved from such plots, the tips and butts are removed, and the large well-nourished grains towards the middle are retained

for next year's sowing. In selecting the plants for seeding purposes, great care is exercised. The nature of the *early growth* is watched, whether upright or creeping. An erect habit of growth is usually associated with earliness, and this is well seen in comparing Allora Spring and Ward's Prolific. The former has an upright growth, and is markedly early, while the latter is of a prostrate or creeping habit, and is only moderately early. The nature of the *flag* is observed whether tough or flabby, narrow or broad, of a dark glaucous green or of a light-green colour. It is generally found that plants with tough narrow upright glaucous-green leaves are more or less rust-resistant. The *stooling qualities* are noted, and, in the early upright growing wheats, this character is not, as a rule, remarkable, but Queen's Jubilee wheat is upright, early, and a good stooler. When *heading* is about to take place, the quality of earliness is closely watched, and the date of heading is invariably given, while the individual plants which are the first to head are specially marked. Then the character of the *ears* and the grain is narrowly scanned, together with the holding or shelling of the grain, and the earliest plants to ripen with the best ears are selected for further use. The character of the *straw* is an important factor, whether weak or flexible, stiff or brittle, long or short, and the *rust-resistance* is carefully determined. The variety tests now being carried out will show their suitability for different climates.

Thus, a process of careful seed selection has been going on for several years, and the result is a number of improved varieties which are gradually being introduced into general cultivation.

Field Plots.—After usually two years' trial on the single seed plots, the promising varieties are reserved for further trial on a larger scale in the field plots. These vary in size according to the amount of seed available, but usually range from 1-16th to 1-32nd of an acre. These plots are of sufficient size to show the pronounced characteristics of the variety, but are mainly used for the purpose of obtaining a fairly accurate idea of the yield. The milling qualities are also determined, and a flour-testing mill has been obtained to test the value of the flour, even from comparatively small quantities of grain.

If the wheats grown in the field plots maintain their early promise, and are likely to prove profitable to the grower,

samples are available for any farmer who wishes to give them a trial as to their suitability for his particular district, and from this seed he can gradually grow sufficient for a general crop. A good illustration of what can be done in this way is afforded by the history of Ward's Prolific Wheat, a well-known rust-resisting variety. In a letter to me, under date 16th January of this year, Mr. James Ward, of South Australia, thus describes the origin of the Prolific Wheat bearing his name—"In the year 1881, Dr. Schomburgh, of the Adelaide Botanic Gardens, forwarded a small parcel of wheat to the Chairman of the Farmers' Association, requesting him to distribute it amongst the members. I obtained a handful, and planted it in my garden, but at harvest time it proved to be as rusty as a horse-nail, with the exception of a few plants which, on examination, proved to be perfectly free from rust. I collected these few ears, and on planting the first year I obtained 1 lb., the second year 50 lbs., the third 7 bags, and the fourth 233 bags."

General Crop.—In the case of specially promising wheats, Mr. Goldie grows a number of acres on his farm, and, through him, the varieties may be obtained in larger quantities for general seeding. In this way, Queen's Jubilee and Improved Allora Spring, for instance, have become distributed, but only small samples are sent out by the Department, in order that the farmer may test their suitability for himself.

In the earlier stages of the experiments it was deemed advisable to grow a large number of varieties, in order to afford a larger area of selection, but now they are being gradually reduced, while new ones are constantly being brought forward. Thus, of the 55 new wheats received from Farrer during the past season, only eleven are retained. It is found, as the result of experiments, that seed from the cool southern districts is very suitable for the warm northern areas, but it remains to be seen how long they will retain their vigour and quality.

Selected Wheats for Distribution.—As the result of the field plot experiments, the following wheats are now available for distribution. The yields were not always determined this season, and I append those of last season at Port Fairy. In the case of Rerraf, however, which is early, holds the

grain well, and has a remarkably clean straw, the yield for this season was found to be at the rate of $31\frac{1}{3}$ bushels per acre :—

Improved Allora Spring ...	32 bushels per acre.		
Rerraf	$31\frac{1}{3}$	„	„
Leak's Rust-resisting ...	$28\frac{1}{4}$	„	„
Mentor	$34\frac{4}{5}$	„	„
Outpost	$28\frac{1}{2}$	„	„
King's	—	„	„
Steinlee	40	„	„ (1897)
Queen's Jubilee	32	„	„

Professor Lowrie, of Roseworthy Agricultural College, South Australia, kindly sent me five varieties for trial, only one of which was found suitable, viz., King's, which is a bearded wheat. His remarks are interesting — "I am sending you half bushel each of King's, Baart, Early Para, Smart's, and Baroota Wonder. If you have these already, the effect of change of seed from here will be interesting. . . . I have sold about 300 bags of King's alone this year for seed-wheat, and I think for the mallee you will find it one of the very best to grow. . . Bearded wheats are not more difficult to strip than some beardless wheats, but farmers object that the box of the stripper becomes so quickly filled that there is time lost in going to and fro to the heap so frequently, and they are, of course, more trouble in winnowing at the heap. But my impression is that the extra yield in mallee lands from these wheats more than covers this disadvantage, and they have other advantages, *e.g.*, hardiness and less liability to shed."

B.—*Variety Tests of Wheat in the Mallee.*

A very common question is—What is the best variety of wheat? But the answer to that question would vary considerably, according to the soil and climatic conditions in which the variety was grown. There is, in fact, no such thing as a best variety for the colony at large, but the most suitable and most profitable for any particular district can only be determined by experimental trials extending over a series of years.

On the right answer to that question, will largely depend the success of a given district in wheat-growing, for an unsuitable variety is a heavy handicap even to the most skilled farmer, while a suitable variety is likely to be more certain in its results other things being equal.

Experiments had been tried in different districts to ascertain the varieties best suited to their requirements, but hitherto the mallee had been overlooked. There is such a striking contrast between it and other wheat-growing areas that it seemed a most promising field for experiments of this nature.

For a number of years, not only the old and standing varieties, but also the new and most promising kinds have been tested at Mr. Goldie's farm, Port Fairy, as well as a number of crosses which Mr. Farrer, wheat experimentalist, of New South Wales, has kindly supplied for a number of years. Thus several varieties were available, worthy of being tried in the dry northern districts.

At the request of the Honorable the Minister of Agriculture, I undertook to test different varieties of wheat in various districts of the mallee, in order to determine, after several seasons' trial, which were most suitable to the prevailing climatic conditions and the most profitable to grow.

The mallee forms a tract of 11,000,000 acres in the northern portion of Victoria, and is so named from the scrub which largely covers it. It has a limited rainfall, but it has been found that wheat will grow with an annual fall of 10 to 12 inches, if it comes at the right season. Cheap methods of clearing, cultivating, and harvesting, by means of the mallee roller, the stump-jump plough, and the stripper, combined with the generally loose nature of the soil, have reduced the cost of production considerably.

The wheat best suited for such a district must be early maturing to escape the hot winds, drought-resisting to thrive even with a limited rainfall, holding the grain well, since the crop must be dead ripe for harvesting with the stripper, together with the essential qualities of being a good milling and prolific-yielding wheat and fairly rust-resistant. The experimental plots were grown under the ordinary conditions of mallee farming, and were limited to one-eighth or one-sixteenth of an acre, because, in several instances, there was not a sufficient supply of the special seed-wheat to sow more.

This season there will be 1-acre plots of the varieties selected for further trial, and uniformity observed in the time of sowing, amount of seed used, &c. The seed-wheat before being sent out was pickled with bluestone to prevent the appearance of bunt, which had been rather destructive the previous season.

Six experiment stations were chosen extending from Swan Hill to Nhill, and two of them were on the mallee fringe. They were at Swan Hill, Waitchie, Tyrrell Downs, Hopetoun, Dimboola, and Nhill.

Only at three of these stations were definite results obtained, the plots at the other three being comparative failures from various causes.

At Dimboola (Mr. Wilson's farm) all the plots were so badly affected with what is locally known as "take all" that no reliable opinion could be formed as to the varieties most suitable for the district. At Hopetoun the plots suffered so much from drought and sparrows that the results were not reckoned, but it was observed that the best varieties seemed to be Improved Allora Spring, Queen's Jubilee, Steinlee, and Mentor.

At Tyrrell Downs the plots were also a comparative failure, but similar varieties to those at Hopetoun seemed to thrive best.

Waitchie Results (A. B. Cobham's).

The experiments at Waitchie were carried out on comparative lines, the amount of seeding being the same for each variety (32 lbs. per acre), and the time of sowing being as near as possible 20th and 21st April generally. On account of the small size of the plots, they were not stripped but reaped, and then threshed with a hand-threshing machine, and the grain cleaned with sieves. The yield was thus carefully and accurately calculated in the case of each variety, and while it may be objected that the wheats ought to have been stripped for a fair comparison, still the results show what different varieties can yield under similar conditions. The 1-acre plots of the coming season will, however, be stripped, in order to show what may be obtained from suitable varieties by the average farmer. There is also a rain-gauge at this station, and, from the careful oversight exercised, the results may be taken as typical of what may be realized in the district. I wish to point out, however, that the yield fluctuates so much from year to year, that a first year's results are not to be too much relied upon, for the average yield for a number of years must be taken if the comparisons are not to be misleading.

The Soil and its Preparation.—The soil was a free sandy loam, and the timber growing on it was mallee, pine, and

small scrub. The land was grubbed, and the scrub burned in March, and immediately afterwards the land was ploughed with a set plough from 10 inches to 1 foot in depth. The soil was then harrowed and rolled, and a good seed-bed was thus prepared.

Sowing.—The wheats were sown between the 17th and 21st April, and drilled in with the Planet Junior at the rate of 3·2 lbs. per acre, and at a depth of about 2 inches, in rows 1 foot apart. This season the seed will be drilled in by a Farmer's Favourite. Eighty-one points of rain fell on the 23rd April, and a successful germination took place. After sowing there was no further cultivation of any kind.

Rainfall.—The rainfall exercises such a commanding influence on the yield, that it is important to note its extent and distribution. The total rainfall for the year was 14·49 inches, but was badly distributed, the fall for the first half-year being 10·72 inches, and for the latter only 3·77 inches. The spring, the season when rain is mostly required, was one of the driest on record. The rain which fell between the dates of sowing and ripening was only 7·37 inches, distributed as follows :—

April	...	...	·84
May	...	...	·75
June	...	...	3·23
July	...	...	·66
August	...	...	·74
September	...	...	·31
October	...	...	·84
			7·37 inches.

Between the 5th and 7th November 1·03 inches of rain fell, but it was too late to benefit the crops, which were already ripe, or nearly so.

Frosts were very severe during the winter, and there were one or two into late spring.

Average Yield.—The average yield of the whole of the crops of the district is returned to me as about 3 bushels per acre, while that of the wheats grown in the trial plots is 20 bushels 49 lbs. per acre, the highest yield being 25 bushels 48 lbs., and the lowest 17 bushels 52 lbs. No manure of any kind was used in these tests.

Varieties worthy of further Trial.—As the result of the experiments of the past season the following varieties are well worthy of being tried on a larger scale, viz. :—Improved Allora Spring, Queen's Jubilee, Steinlee, Outpost, and Mentor, and, for purposes of comparison, Steinwedel and ordinary Allora Spring might be grown together, as these two varieties are already largely grown in the district.

Stinking Smut.—Special search was made for stinking smut, in order to test the efficacy of the treatment, but none was found on any of the varieties with the exception of Hudson's Early Purple Straw. After diligent search, three smutted heads were found, but otherwise free, and I can only account for even these appearing in the plots from a stray smut-ball having escaped the treatment. If the seed is carefully treated with bluestone solution and the smut-balls skimmed off, there ought to be no trace of the disease in clean ground.

Remarks on the Early Varieties.

1. Improved Allora Spring from Port Fairy gave the heaviest yield of all, but has the same liability to shell as the ordinary kind. It headed eleven days earlier than Allora Spring from Dookie, although both ripened together on the 9th November. The great difference between the two, however, was the yield—25 bushels 48 lbs. (Port Fairy) and 19 bushels 4 lbs. (Dookie).

2. Queen's Jubilee is one of Farrer's crosses, and as it was the premier wheat of the season, as far as yield was concerned (42 bushels) at Port Fairy in 1897, I gave it what I considered an appropriate name. It is the following cross :—(Leak's × Hornblende) × (Ward's White × Tourmaline). It is comparatively early, heading on 25th September, and ripe on 7th November. It has many good qualities, strong straw, splendid heads, plump grain, holds the grain well, and yields well, and is a good stooler. It also stands drought, and is not tipped, but is somewhat liable to rust, although it might prove rust-escaping to a large extent on account of its earliness. The grower says, "For a general stripping crop, for the mallee of a considerable area, this wheat is undoubtedly the best available."

3. Outpost is a recent cross of Mr. Farrer's which promises well. It has a good strong straw, holds the grain

well, and is a heavy yielder. It is also particularly hardy, sustaining little or no damage from frosts and hot winds, and should prove a good wheat for the mallee.

4. Steinlee is earlier than any other variety tried, being ripe on 1st November. It has a splendid grain, and is a heavy yielder. The variety is not quite fixed, being partly bearded and partly bald, but the beard generally drops off on ripening. It has the defect of being weak in the straw, and is therefore not a good stripping wheat.

5. Mentor resembles Steinlee, but it was later, and did not yield so well. However, at Nhill, it was the first to ripen, and yielded 24 bushels per acre.

6. Allora Spring only yielded 19 bushels 4 lbs., as compared with 25 bushels 48 lbs. from the improved form, and therefore the latter should be preferred. The remaining wheats were found to be too late to suit the climate, but my object in sending them was to provide wheats ripening in succession, so that all might not be ready for stripping at the same time, and, at some of the other stations, they succeeded so well as to merit their continued cultivation.

Nhill Results (G. Batson's).

The land is situated on the mallee fringe, and consists of open plain soil. The previous cropping was oats, following a crop of wheat off fallow, then one year's spell and fallowed again. The land was ploughed, three times harrowed in summer, and the wheat scarified in and harrowed once, then fed off with sheep after it was about six weeks above ground. Sowing took place from 6th to 8th May. All the plots were reaped and threshed, and the yields carefully weighed. The average of the paddock in which the plots were situated was 15 bushels per acre (Purple Straw), while that of the plots was 21 bushels 7 lbs. There were some very severe frosts, which did a deal of damage, particularly to Steinlee, which is very susceptible. The rainfall was 13 inches 81 points for the year.

Varieties worthy of further Trial.—The wheats which yielded well and evidently suited the district are the following:—Queen's Jubilee, Mentor, Rattling Tom, Farmer's Friend, Hudson's Early Purple Straw, Outpost, and Improved Allora Spring.

I am informed that there was a little stinking smut in all the plots, but badly smutted wheat, treated in a similar way and sown at Port Fairy, showed no signs of stinking smut.

Swan Hill Results (N. B. Bryan's).

The soil is true mallee land, consisting of firm sand. It was laid out in grass for about four years, and then broken up. The land was ploughed and harrowed, then rolled to break up the lumps, in order that the seed might be regularly drilled in by the Planet Junior. The average rate of sowing was ¾ bushel to the acre, and took place from 6th to 12th May. Special examination was made for stinking smut, but none was found, although in some plots loose smut occurred, showing that the ordinary bluestone treatment is not effectual against that particular smut. The average yield was only 9 bushels 29 lbs., the plots at Waitchie and Nhill yielding 20 to 21 bushels. The plots were stripped instead of being reaped, and mostly on 30th November, but otherwise the conditions were similar. Steinwedel was sown as one of the plots, and gave the highest yield, viz., 11 bushels 32 lbs., closely followed by Improved Allora Spring, which yielded at the rate of 11 bushels 28 lbs. per acre. In comparing the yields with those at Waitchie, for instance, there is a very striking difference, but one fact should be noticed, that while at Waitchie the land was ploughed to a depth of 10 to 12 inches, at Swan Hill it was only 4 inches.

Varieties worthy of further Trial.—As far as this year's tests go, there are none of the varieties superior in yield to the Steinwedel, already so largely grown, but several will be tried on the 1-acre plot this season. In every case the wheats will be stripped, and thus a comparison can be fairly instituted between the other experimental stations. Steinlee is retained on account of its earliness, and, in addition, Improved Allora Spring, Queen's Jubilee, and Outpost.

Conclusion.

The testing of varieties, as to their suitability for particular districts, is a most necessary and most important work for an Agricultural Department, and should gradually include all the principal products grown on a commercial scale. Improved varieties of wheat form the

subject of these experiments, and even a first year's trial in the mallee shows how much may be gained by growing the right sorts. But, to be of permanent value, such experiments should extend over a number of years, so as to meet the requirements of the varying conditions of soil and climate. The variety tests of wheat were begun, in the first instance, to discover those which were more or less rust-resistant, and now they are being tested in the large wheat-growing areas. Every year new and promising varieties are being carefully tested, and the most profitable are being distributed amongst the farmers. A change of varieties is constantly going on, and will continue to do so as long as farmers are seeking for something better than they already possess.

In connexion with the variety tests, a number of other important points can be settled for the mallee farmer, which it is essential should be known, even for obtaining the best results out of a well-selected and suitable variety of wheat. The methods of seeding, such as drilling or broad-casting, depth of seeding, thick and thin sowing, rolling before and after seeding, preparation of the seed-bed, change of seed, and the best time to sow, should all be made the subject of experimental tests.

The object of the farmer is to make as much out of his land as possible without exhausting it, and in wheat-growing the selection of a suitable variety, and the purity of the seed, are of primary importance. Deterioration often occurs either from carelessness in selecting the seed-wheat or allowing it to get mixed. The advantages of selection are well known, and the Allora Spring wheat, which has been improved by selection for a number of years at Port Fairy, is a case in point. The purity of the seed has likewise to be attended to, for, if mixed, there may be uneven ripening and difference in the length and strength of straw, a cause of trouble and loss.

While every effort is being made to increase the yield by selection and purity of seed, deep cultivation of the soil, and a proper rotation, the question of fertilizers must also be considered, and comparative experiments should be made to see how far the addition of fertilizers of the right kind and in the right way affect the yield. In some cases, the application of fertilizers has had no appreciable effect on the yield of grain or straw, and, like every other practical agricultural problem, it has to be submitted to the test of experiment.

The matter has been put so clearly by Mr. Cobham, of the Waitchie Experimental Station, that I will allow him to speak for the farmers. He writes—"It is an open question whether the mallee wheat crops of the past five seasons have given an average yield of 3 bushels per acre right through. This, no doubt, is chiefly due to deficient rainfall. It is, in part, due to bad cultivation, to late sowing, and to unsuitable varieties of wheat being grown; but much of the mallee soil bears an impoverished appearance. The soil varies a good deal, but no analysis has been made of any soil in this part of the mallee, as far as is known. Some of the principal elements necessary to the production of wheat may be deficient in quantity, or almost absent. A series of experiments with different manures would be a practical test as to whether manuring will pay in the mallee, and, if so, what kind will return the most profit. A better return than 3 bushels per acre in the mallee is absolutely necessary to insure the rapid development of this vast area."

It is encouraging to note that the farmers of the various districts are taking a lively interest in the experiments, and many of them are beginning to learn that it is more profitable to cultivate less land and cultivate it better.

Although the experimental work in the testing of varieties is as yet in its infancy, it is safe to predict from the experiments already made that, with thorough cultivation, early sowing, suitable and carefully selected seed-wheat, combined with the most economical system of manuring, good and profitable yields may be safely reckoned on.

TABLE I.—VARIETY TESTS OF WHEAT.—COMPARATIVE YIELDS.

Name of Variety.	Stations.					
	Waitchie.		Nhill.		Swan Hill.	
	bush.	lbs.	bush.	lbs.	bush.	lbs.
Allora Spring	19	4	16	0	11	8
Improved Allora Spring	25	48	21	52	11	28
Ward's Prolific	18	13	16	0	7	52
Hudson's Early Purple Straw ...	18	56	23	8	7	56
Queen's Jubilee	24	8	24	0	10	52
Outpost	23	44	22	0	10	12
Farmer's Friend	17	52	23	28	8	56
Rattling Tom	19	44	26	24	8	56
Mentor	21	20	24	0	8	40
Steinlee	23	44	12	48	8	24
Fill Bag	16	24	22	40	7	52
Steinwedel	...		...		11	32
Average yield	20	49	21	7	9	29

TABLE II.—VARIETY TESTS OF WHEAT IN THE MALLEE.—SPECIAL CHARACTERISTICS.

Variety.		Seed Obtained from—	Area Sown.	Quantity Sown per acre.	Date of Sowing.	Time of Heading.	Ripe.	Height.	Yield per acre.	Remarks.
			Acre.	lbs					bush. lbs.	
Improved Allora Spring	W.	Port Fairy ...	1/18	32	20th April	19th Sept.	9th Nov. ...	3½ feet ...	25 48	Stools fairly well; liable to shell.
	N.	" ...	1/16	56	8th May	23rd Oct.	14th Dec. (reaped)	... ...	21 52	Good stooling wheat.
	S.	" ...	1/16	53	8th May	5th Oct.	30th Dec. (stripped)	Short ...	11 28	Stiff and short straw.
Queen's Jubilee	W.	Port Fairy ...	1/8	32	20th April	25th Sept.	7th Dec. ...	3½ feet ...	24 8	Good stooler; holds very well. Best all-round wheat for a large area.
	N.	" ...	1/8	48	8th May	21st Oct.	14th Dec. (reaped)	... ...	24 0	Stands drought, and not tipped.
	S.	" ...	1/8	49	9th May	7th Oct.	30th Nov. (stripped)	Short ...	10 52	Holds well.
Outpost	W.	Port Fairy ...	1/8	32	20th April	5th Oct.	12th Nov. ...	Medium ...	23 44	Stools well, and holds very well. Promises to be a useful wheat for the mallee.
	N	" ...	1/8	48	6th May	23rd Oct.	14th Dec. (reaped)	... ...	22 0	Stools well.
	S.	" ...	1/8	52	10th May	13th Oct.	30th Nov. (stripped)	Short ...	10 12	Straw short and rather weak.
Steinlee	W.	Port Fairy ...	1/16	32	17th April	8th Sept.	1st Nov. ...	Good height	23 44	Poor stooler; holds well. Grain very large and plump.
	N.	" ...	1/16	32	6th May	4th Oct.	14th Dec. (reaped)	... ...	12 48	Weak straw; inclined to lay. Delicate wheat, and severely affected by frost.
	S.	" ...	1/16	45	11th May	28th Sept.	30th Nov. (stripped)	Short ...	8 24	Straw rather weak.
Mentor	W.	Port Fairy ...	1/16	32	17th April	27th Sept.	11th Nov. ...	Medium ...	21 20	Poor stooler; holds well. Grain large and plump.
	N.	" ...	1/16	48	8th May	10th Oct.	8th Dec. (reaped)	... ...	24 0	The first to ripen.
	S.	" ...	1/16	49	10th May	10th Oct.	30th Nov. (stripped)	Short ...	8 40	Straw weak; sheds very little.
Rattling Tom ...	W.	Port Fairy ...	1/16	32	21st April	18th Oct.	13th Nov. ...	Medium ...	19 44	Stools well; shells badly.
	N.	" ...	1/16	56	8th May	...	14th Dec. (reaped)	... ...	26 24	
	S.	" ...	1/16	50	10th May	15th Oct.	7th Dec. (stripped)	Short ...	8 56	Sheds very little. Late.
Allora Spring ...	W.	Dookie ...	1/8	32	21st April	30th Sept.	9th Nov. ...	Medium ...	19 4	Stools fairly well; shells easily.
	N.	" ...	1/8	48	8th May	7th Oct.	14th Dec. (reaped)	... ...	16 0	
	S.	" ...	1/8	46	6th May	5th Oct.	30th Nov. (stripped)	... ...	11 8	Shells badly; a good deal tipped.
Hudson's Early Purple Straw	W.	Dookie ...	1/8	32	21st April	20th Oct.	15th Nov. ...	Rather short	18 56	Stools well; holds fairly well, but heads rather brittle.
	N.	" ...	1/8	48	8th May	23rd Oct.	14th Dec. (reaped)	... ...	23 8	
	S.	" ...	1/8	50	9th May	15th Oct.	7th Dec. (stripped)	Short ...	7 56	Holds fairly well.
Ward's Prolific ...	W.	Dookie ...	1/19	32	20th April	20th Oct.	15th Nov. ...	Short ...	18 13	Holds grain; stools well, but heads very thin, and grain poorly developed.
	N.	" ...	1/16	48	8th April	...	14th Dec. (reaped)			
	S.	" ...	1/16	52	8th April	...	30th Nov. (stripped)	... ...	7 52	Useless.
Fill Bag	W.	Port Fairy ...	1/8	32	20th April	15th Oct.	17th Nov. ...	Medium ...	16 24	Stools well, but rather late.
	N.	" ...	1/8	...		...	14th Dec. (reaped)	... ...	22 40	Badly affected with frost.
	S.	" ...	1/8	47	12th May	15th Oct.	7th Dec. (stripped)	Short ...	7 52	Sheds very little.
Farmer's Friend ...	W.	Port Fairy ...	1/16	32	20th April	15th Oct.	15th Nov. ...	Good height	17 52	Stools well; grain rather pinched.
	N.	" ...	1/16	56	8th May	...	14th Dec. ...	... ...	23 28	Worthy of further trial.
	S.	" ...	1/16	46	10th May	15th Oct.	7th Dec. (stripped)	Short ...	8 56	Sheds very little.

W. = Waitchie Experiment Station (A. B. Cobham). N. = Nhill Experiment Station (G. Batson). S. = Swan Hill Experiment Station (N. B. Bryan).

C.—*Variety Tests of Cereals at Leongatha.*

There are single seed plots, and large to medium plots of wheat, oats, and barley; 42 distinct varieties of wheat altogether; four of oats, and thirteen of barley. One of the striking wheats is Queen's Jubilee, which attained a height of 5ft. 6in. to 6 feet, and although comparatively rusty, even with black rust on sheath, still its earliness seemed to prevent serious damage being done. Italian battledore is one of the best barleys. The percentage of rust on the different varieties was carefully noted, and it was observed that the same varieties in the single seed plots were less rusty than in the general crop.

IV. Stinking Smut Experiments in the Mallee and at Port Fairy, Leongatha, and Longerenong Agricultural Colleges.

In the mallee all the experimental plots, consisting of an eighth of an acre each, were sown with seed-wheat, pickled with bluestone, simply to test whether the pickling would entirely prevent the appearance of stinking smut. There was a considerable amount of loose smut, but the stinking smut was absent, except in one plot of Hudson's Early Purple Straw, where, by careful searching, three or four bunted ears were found in one stool. Judging by other experiments, this bunt must either have got into the ground in some way, or, in treating this particular variety, the bunt-balls were not carefully skimmed off.

As the most extensive experiments were carried out at Port Fairy, where 27 different plots were sown, including checks, they may simply be referred to.

Badly bunted purple straw seed-wheat was taken and treated in various ways, and the following were free —

1. Treated with bluestone, 1 lb. to 4 gallons water, and sown when dry.

2. Treated with bluestone, 1 lb. to 4 gallons water, and dipped in lime water.

3. Treated with bluestone, 1 lb. to 4 gallons water, and sown without drying.

4. Dipped for three minutes in a solution of corrosive sublimate (1 in 1,000), and then air-dried. This was considered the best plot of wheat.

In addition to these main experiments, numerous small packets of seed-wheat were sent out to farmers in various districts for trial, and, as a result, some are growing varieties found to be suited to the district on a larger scale.

PRELIMINARY REPORT.

V. Experiments with Tobacco Mould at Government Farm, Edi, and Mr. Temple Smith's Tobacco Plantation.

At the request of the Honorable the Minister of Agriculture, I am carrying out this season a series of experiments in connexion with the tobacco mildew.

Its ravages are only too well known in tobacco-growing districts, and it has become so prevalent in certain parts of the colony that the tobacco industry is threatened.

Experiments were commenced some years ago, but, unfortunately, they were discontinued, and now they have been resumed again, and it is believed that they will prove as successful as at Deli, in Sumatra, where a similar disease has been practically overcome, so that what was formerly a widespread and destructive disease is now only sporadic.

In order to test the efficacy of various treatments for tobacco mildew under our conditions, a number of experimental plots have been laid out, and the results will be published at the end of the season, although it will require several years experimenting before final conclusions can be arrived at, owing to the varying conditions of the climate.

In conjunction with Mr. Bondurant, the tobacco expert, a thorough test is being made at the Experimental Farm, Edi, and Mr. Temple Smith is carrying out a similar series of experiments, under my supervision, at Cheshunt.

Some of the land chosen was sown with tobacco last year, and some is virgin soil.

The seed sown was locally grown on the Experimental Farm, and a measured quantity mixed with sand was applied to each bed.

There are 40 seed beds at each station, arranged in four rows of ten each. Each bed is 3 feet square, and a space of 2 feet square is left between each. Two rows are laid out east and west, and two north and south, to see what effect direction of the beds may have on the appearance or prevalence of the mildew.

Two rows are also burnt, and two unburnt, in order to observe the effect of the burning of the beds on the disease.

In each row, there are two check plots, so that if the season should be unfavorable to the development of the mildew, these untreated plots will serve as a test or standard for the others.

Three systems are being tried this season, applied principally at two different stages—

1. Bordeaux mixture is used for spraying, in the proportion of 2 lbs. bluestone, 2 lbs. unslacked lime, and 10 gallons water.
2. A strong solution of bluestone alone, at the rate of 4 lbs. to 50 gallons water ; and
3. A weak solution of bluestone, at the rate of 4 oz. to 50 gallons water.

These are applied on some beds the same day as the seed is sown, on others only after the plants are well germinated, and afterwards once in five days, or at other times after heavy rains, or in moist weather.

In some cases soft soap is added to the Bordeaux mixture in equal proportions to the bluestone, in order to make it adhere all the better to the leaves. Some of the beds are likewise covered with fine hessian, and others left uncovered to see whether open or covered beds are least liable to the disease.

It has often caused surprise and excited comment that the cultivated tobacco should be affected with a disease in Australia which is unknown in the United States; but within the last few months I have been able to clear up that point satisfactorily. There is a *Wild Tobacco*, native to Australia (*Nicotiana suaveolens*), and on that I have found,

destroying the leaves, the self-same fungus which attacks the cultivated plant, viz., *Peronospora hyoscyami*, De Barry. This is simply an illustration of what is not at all uncommon —a fungus on a native wild plant attacking the more juicy and more highly nourished cultivated plant of an allied species, and becoming epidemic in its character. Further, there is what is known as *Tree Tobacco* in Victoria (*Nicotiana glauca*), imported from America, and this has been found to be infested with tobacco mildew there, so that there is a danger from that source also.

Finally, among many of the growers, there is a widespread belief that the weather is the cause of the mildew, and that, in seeking to control it, you are simply attempting the impossible. I was greeted with the same remark when I undertook experiments with the "black spot" of the apple, but facts have been too strong for even old growers, and we seldom hear the cry now. Dr. De Haan, at Deli, followed out a scientific method in dealing with the bibit disease, as it is called there, and was successful; and now that "black spot" of the apple, "leaf curl" of the peach, "black spot" of the vine, and "stinking smut" of wheat have yielded to scientific treatment, it is hoped that the ridiculous nonsense often uttered by so-called experts may be estimated at its true value. Tobacco mould was practically absent this season, so that the effects of the different treatments were not tested further than to show how far they influenced the germination and growth of the young tobacco plant. The experiments will be continued next season.

IV.—Library.

The nucleus of what will yet become an important branch of the Agricultural Department is being formed in the establishment of a Library and Laboratory, a Museum and Herbarium, and the materials are at present being got together.

A well-furnished Library is necessary for the proper determination and naming of specimens, and a knowledge of the best experience in applying remedies for disease.

A properly-equipped Laboratory is requisite for carrying out the necessary investigations into the nature and habits and life-histories of the various disease-causing or injurious fungi.

The Herbarium is a necessary complement to the Library and Laboratory, because it contains actual specimens of the forms which are being discussed or investigated, or, as is often the case in dealing with new forms, it is necessary for comparison and reference.

The Museum is, in a sense, the living embodiment of the whole, for there are displayed the various forms of disease, in such a way and with such aids of drawing and description as will enable the grower most effectually to realize the nature and symptoms of the trouble, together with the best methods of combating it.

It is absolutely necessary to have the best as well as the latest literature in this branch, and a number of standard works have been procured, as well as donations received. Here, again, the want of some accessible place is severely felt, for the inspectors of orchards and others would profit greatly by consulting works relating to their subject. A special collection is being made of all works, pamphlets, &c., relating to Australian fungi, and this should prove very useful to future investigators as showing what has been already done.

Purchased Works.

A few of the principal ones are here noted—

Berlese. Icones Fungorum.

Berlese. Fungi Moricolae.

Cooke. Illustrations of British Fungi. Vols. 1–8 (complete).

Cooke. Mycographia.

Corda. Icones Fungorum.

Corda. Mucedines.

Crookes. The Wheat Problem.

Ellis and Everhart. North American Pyrenomycetes.

Eriksson and Henning. Die Getreide Roste.

Frank. Die Kranhheiten der Pflanzen ; 3 vols.

Grevillea, a Quarterly Record of Cryptogamic Botany. Vols. 1–22 (complete).

Hartig and Somerville. Text-book of the Diseases of Trees.

Hedwigia, Organ für Kryptogamenkunde und Phytopathologie.

Journal of Mycology. Vols. 1–7 (complete).

Kirchner and Boltshauser. Atlas der Krankheiten und Beschadigungen unserer landwertschaftlicen Kulturpflanze.

Koernicke and Werner. Handbuch des Getreidebaues.

Lister. Mycetozoa.

Massee. British Fungus Flora. Vols. 1–4.

Massee. A Text-book of Plant Diseases caused by Cryptogamic Parasites.

Massee. A Monograph of the Myxogastres.

Prillieux. Maladies des Plantes Agricoles; 2 vols.

Roze. Histoire de la Pomme de Terre.

Saccardo. Sylloge Fungorum; 14 vols.

Sorauer. Pflanzenkrankheiten; 2 vols.

Tubuef and Smith. Diseases of Plants.

Viala. Les Maladies de la Vigne.

Vilmorin-Andrieux and Co. Les meilleurs Blés.

Zeitschrift für Pflanzenkrankheiten. Edited by Dr. Sorauer. Vols. 1–9 (continued).

Publications presented to Library.

These include the following:—

Canada. Ottawa Central Experimental Farm. Ontario (Guelph).

Cape of Good Hope. Department of Agriculture.

Colonial Agricultural Departments—

Victoria.

New South Wales.

Queensland.

South Australia.

West Australia.

Indian Government Publications.

United States Department of Agriculture and the various American Agricultural Experiment Stations.

V.—Laboratory.

The apparatus is not very extensive, but it is constantly being added to. Only the most necessary microscopes and appliances are provided at present.

A photo-micrographic apparatus has just recently been purchased. Mr. G. H. Robinson, assistant, has taken up this line of work, which is becoming more and more necessary. Examples of it have already been given in the works issued on vine and citrus diseases.

The want of suitable accommodation seriously hampers me in the work of investigation. Nevertheless, several hundred new species of fungi have been described, and drawings made of the most important features.

VI.—Herbarium Specimens.

These are at present disposed in boxes and arranged according to Saccardo's *Sylloge Fungorum*. They are constantly being added to from the numerous new species being forwarded for determination from different parts of Australia, and I hope to have typical species preserved of all known Australian fungi. There is a large addition to the list since the publication of the "Systematic Arrangement of Australian Fungi," in 1895, and it will form a fitting close to the century to have all the descriptions published during 1900.

I am indebted to various contributors for specimens of Australian fungi, and would specially mention Messrs. Maiden and Baker, in New South Wales ; Messrs. Molineux, Tepper, and Quinn, in South Australia ; and Messrs. Eckert, French, Reader, and Robinson, in Victoria ; in addition to the various inspectors under the Vegetation Diseases Act.

Extra.—Australian specimens have been procured by purchase, and consist of—

Sydow's Uredineae, Nos. 1–1,400.
Sydow's Ustilagineae, Nos. 1–200.
Eriksson's Pucciniae, Nos. 401–450.
Briosi and Cavara's "I Funghi Parassiti delle Piante Coltivate od utili." Fascicles 1–12.

Mr. Bailey, F.L.S., Colonial Botanist of Queensland, kindly presented to the Herbarium 152 specimens of Queensland blight fungi, the names of which are recorded in the "Proceedings of Conference of Australasian Fruit-growers," held

at Wellington, New Zealand, May, 1896 ; and Mr. Lister, F.L.S., author of "A Monograph of the Mycetozoa," has also presented 51 specimens of Myxomycetes to the Herbarium.

I am also indebted to Mr. Galloway, Chief of the Division of Vegetable Physiology and Pathology, United States Department of Agriculture, for the following specimens of diseases of cultivated *Vitis* species :—

Plasmopara viticola, Berl. and De Toni.
Uncinula necator, Burrill.
Laestadia bidwellii, V. and R.
Coniothyrium diplodiella, Sacc.
Septoria ampelina, B. and C.
Glœosporium ampelophagum, Sacc.
Cercospora viticola, Sacc.
Septosporium heterosporium, Ell. and Gall.

In investigating new species of fungi, descriptions are drawn out and drawings made. Then a typical specimen is preserved for the Herbarium and microscopic slides for the cabinet. There are already over 1,500 mounted microscopic specimens illustrative of the fungi, and they are necessary in addition to the actual specimens for verifying the position assigned to any fungus.

VII.—Museum Specimens.

These form a necessary adjunct to the Herbarium, and consist of specimens either preserved in bottles or displayed in cases, when rather large for the Herbarium, such as trunks and roots of trees affected with fungus disease. There are also a number of photographs of diseased plants, and a complete set of Sorauer's "Atlas der Pflanzenkrankheiten," consisting of 48 plates, mounted in frames, but in the absence of suitable accommodation the specimens cannot be displayed to advantage. Numerous mounted wheats, correctly named seeds and their adulterants in glass tubes, &c., have to be packed away for the same cause. By not having a properly-equipped Museum in which specimens could be exhibited with explanatory cards, pointing out their special

features, the Agricultural Department is neglecting one of the most effectual means of educating the farmer and the fruit-grower, the vigneron, and the market gardener.

VIII.—Publications.

The following have been issued since my appointment. Some of them are rather elaborate, such as, "The Systematic Arrangement of Australian Fungi," which is a work of 236 pages, and the "Fungus Diseases of Citrus Trees in Australia and their Treatment," is illustrated by 12 coloured plates, and 186 figures :—

1. Report of the Vegetable Pathologist. Bulletin No. 12. Department of Agriculture, Victoria, 1890.

2. The Life-history of the Rust of Wheat. Bulletin No. 14. Ibid. Plates I. and II., 1891.

3. Rust of Wheat. Bulletin No. 14. Ibid.

4. Report on Wheat Blight (*Septoria tritici*, Desm.). Bulletin No. 14. Ibid.

5. Report on Club-root of Cauliflowers, Cabbages, Turnips, and other Cruciferous plants. Bulletin No. 14. Ibid. Plate III.

6. Beet-leaf Rust or Blighted Mangel Leaves (*Uromyees betae* Kuehn). Bulletin No. 14. Ibid.

7. Root-fungus of Raspberry. Bulletin No. 14. Ibid.

8. Root-gall Disease of Cucumbers. Bulletin No. 14. Ibid.

9. Report on Peach and Plum Leaf Rust (*Puccinia pruni*, Pers.). Bulletin No. 14. Ibid. Plates V. and VI. Guides to Growers, No. 5.

10. Report on Rust in Wheat. Proceedings of Rust in Wheat Conference, New South Wales, 1891.

11. Ueber die Verwendung geschrumpfter Koerner von rostigem Weizen als Saatgut. [On the use of Rust-shrivelled seed for sowing.] Zeitschrift f. Pflanzenkrankheiten. Vol. II., Part 4, 1892.

12. Report on Rust in Wheat. Proceedings of Rust in Wheat Conference, South Australia, 1892.

13. Report on a poisonous species of Homeria (*H. collina*, Vent., var. *miniata*) causing death of cattle feeding upon it. Proc. Roy. Soc., Victoria, 1893.

14. Systematic Arrangement of Australian Fungi, together with Host Index, and List of Works on the subject. 1893.

15. Botanical Nomenclature, with special reference to the Fungi. Proc. Aust. Assoc. Adv. Sci., Adelaide. Vol. V., 1893.

16. Native Bread (*Polyporus mylittae*, C. and M.). Austr. Journ. Pharm. VIII. 1893.

17. The undescribed Uredospores of *Puccinia burchardiae*. Vict. Nat. X., 1893.

18. Report on Rust in Wheat Experiments at School of Horticulture, Burnley. Illustrated with maps and drawings. Department of Agriculture, Victoria, 1894.

19. Report on Rust in Wheat. Proceedings of Rust in Wheat Conference, Queensland, 1894.

20. Spraying for Fungus Diseases. Guides to Growers, No. 15, 1894.

21. A new Australian Stone-making Fungus (*Laccocephalum basilapidoides*, McAlp. and Tepp). Proc. Roy. Soc., Victoria, 1894.

22. The Entomogenous Fungi of Victoria. Ibid, 1894.

23. Australian Fungi. Ibid, 1894.

24. Report on Onion Disease (*Tylenchus devastatrix*, Kuehn). Guides to Growers, No. 18.

25. Note on specimen of Edible Mushroom (*Agaricus campestris*), with second smaller inverted pileus on top. Vict. Nat. XII., 1895.

26. Report on Fungus (*Meliola amphitricha*, Fr.) on *Dysoxylon rufum*. New South Wales. Proc. Linn. Soc., N.S.W., 1895.

27. Notes on *Uromyces amygdali*, Cooke. A Synonym of *Pucinia pruni*, Pers., or Prune Rust. Ibid, 1895.

28. Groundsel Rust with trimorphic Teleutospores. Ibid, 1895.

29. Entomogenous Fungi. Vict. Nat. XII., No. 6, 1895.

30. Australian Fungi. Ag. Gaz., N.S.W., Vol. VII., Part 11, 1895.

31. Australian Fungi. Ag. Gaz. N.S.W., Vol. VII., Part 12, 1895.

32. Australian Fungi. Ag. Gaz., N.S,W., Vol. VIII., Part 2, 1896.

33. Australian Fungi. Ag. Gaz., N.S.W., Vol. VIII., Part 3, 1896.

34. Australian Fungi. Ag. Gaz., N.S.W., Vol. VIII., Part 5, 1896.

35. Descriptions of New Australian Fungi. Proc. Linn. Soc., N.S.W., 1896.

36. A Fungus on a Beetle (*Botrytis angulata*, n. sp.). Vict. Nat. X. No. 4, 1896.

37. Fungus Pests and Remedies for their Suppression. Guides to Growers, No. 27, 1896.

38. The Sooty Mould (*Capnodium citricolum*, n. sp.) on Citrus Trees—a study in Polymorphism. Proc. Linn. Soc., N.S.W., 1896.

39. Two Additions to the Fungi of New South Wales. Proc. Linn. Soc., N.S.W., 1896.

40. Report on the Rotting of Apples. Guides to Growers, No. 30, 1897.

41. Some South Australian Forms of *Cordyceps Gunnii*, Berk. Ag. Gaz., N.S.W., Vol. VIII., Part 3, 1897.

42. New South Wales Fungi. Proc. Linn. Soc., N.S.W., 1897.

43. Wheat Experiments, Season 1896. Guides to Growers, No. 31, 1897.

44. Fungus Diseases of the Raspberry. Guides to Growers, No. 32, 1897.

45. Rust in Wheat Experiments, 1894 to 1896–7. Guides to Growers, No. 35, 1897.

46. New South Wales Fungi. Proc. Linn. Soc., N.S.W., 1897.

47. Bakterienkrankheit der Maulbeerbäume [Bacteriosis of the Mulberry]—Zeitschrift f. Pflanzenkrankheiten, Vol. VIII., Part 3, 1898.

48. Additions to the Fungi on the Vine in Australia (with 80 figures). Gov. Printer, Melbourne, 1898. Reprint.

49. A Statistical account of Australian Fungi up to the end of 1897. Proc. Aust. Assoc. Adv. Sci., Sydney, 1898.

50. Wheat Experiments, Season 1897–8. Guides to Growers, No. 37, 1898.

51. Ueber die Anwendung von Fungiciden bei Weinstocken. [On the application of Fungicides to the Vine.] Zeitschrift f. Pflanzenkrankheiten, Vol. VIII., Part 1, 1898.

52. Experiments with Fodder Plants. Guides to Growers, No. 38, 1898.

53. A new Myxomycete for New South Wales. Proc. Linn. Soc., N.S.W., 1898.

54. Report on Fairy Rings and the Fairy Ring Puff-ball (*Lycoperdon furfuraceum*, Schaeff). Gov. Printer, Melbourne, 1898.

55. The Fungi on the Wheat-plant in Australia. Ag. Gaz., N.S.W., Vol. IX., Part 9, 1898.

56. Rust in Wheat during the dry season of 1897. Ag. Gaz., N.S.W., Vol. IX., Part 12, 1898.

57. Bunt or Stinking Smut of Wheat and its Treatment. Guides to Growers, No. 44, 1899.

58. Three Additions to the Fungi of New South Wales. Proc. Linn. Soc., N.S.W., 1899.

59. Fungi from Kerguelen Island.—Proc. Linn. Soc., N.S.W., 1899.

60. Plant or Animal—Myxomycete or Mycetozoon. Vict. Nat., Vol. XVI., No. 6, 1899.

61. A new Parasitic Agaric (*Hebeloma frenchii*, n. sp.). Vict. Nat., Vol. XVI., No. 7, 1899.

62. On a Micro-fungus from Mount Kosciusko ; and on the first record of *Uncinula* in Australia. Proc. Linn. Soc., N.S.W., 1899.

63. Two Mallee Fungi. Vict. Nat., Vol. XVI., No. 9, 1899.

64. Brief Report on Locust-fungus imported from the Cape (*Mucor racemosus*, Fres.). Ag. Gaz., N.S.W., Vol. X. Part 11, 1899.

65. Fungus Diseases of Citrus Trees in Australia, and their Treatment. Twelve coloured plates, and 186 figures. Gov. Printer, Melbourne, 1899.

IX.—Miscellaneous.

In the course of the year, a number of matters were submitted, some of which do not properly come under any of the previous headings, and in my visits to different districts information was given to the growers bearing upon the diseases prevalent and the best methods of treatment. The determination of various agricultural seeds and of different varieties of wheat, supposed poison plants, &c., were made, and I select a few examples of the most generally interesting subjects.

Report on Analyses of Samples of Sulphate of Copper made by A. N. Pearson, Agricultural Chemist.—It was frequently asserted in the press and elsewhere that the bluestone supplied to farmers for treatment of their seed-wheat was largely adulterated, principally with copperas or sulphate of iron, and that was given as the main reason why even treated seed-wheat was badly affected with stinking smut or bunt. I was rather inclined to attribute the prevalence of smut, where the seed was ostensibly treated, to faulty methods, from personal observations made at various places in the mallee and other districts.

To settle the matter definitely, I obtained, indirectly, through farmers themselves, a number of samples for analysis, the only direct specimen obtained being that from Messrs. Felton, Grimwade, and Co. In this way samples were taken over a wide extent of country, and included the following:—Dimboola, Nhill, Hopetoun, Swan Hill, Horsham, Wallaroo Smelting Company, and Messrs. Felton, Grimwade, and Co., Melbourne. Sometimes as many as four samples were taken from different storekeepers in the

same district, and in the majority of cases the samples contained less than 1 per cent. of sulphate of iron, and only in one instance did it approach 2 per cent.

This is a very satisfactory result; for a small amount of sulphate of iron is always present in commercial bluestone as an inevitable impurity from the mode of manufacture. So long as the amount does not exceed 5 per cent. of sulphate of iron it is within the reasonable limits of impurity. Mr. Pearson remembers only one case of serious adulteration which came under his notice in this colony in 1896, when a sample of bluestone was found to contain 85 per cent. of sulphate of iron.

Supposed Poison-plant.—In some of the dairying districts around Melbourne, there is a weed growing very profusely, known as *Romulea bulbocodium*, Sebast., which is a native of Southern Europe, as well as Asia and Africa, and has been imported into Victoria. It belongs to the Iris family, and was mistaken by some of the dairymen for the Cape Tulip, which is a species of *Homeria*, and is undoubtedly poisonous. I may mention, in passing, that the common names of plants when given alone are responsible for a deal of misunderstanding, and in all official publications at least the scientific names should be given, in spite of the sneers of the vulgar. There is a harmless weed in the Port Fairy district which is rather evil smelling, and the farmers there call it stinkwort, while in the present instance the weed was called Cape Tulip, and so it was bound to be poisonous. Mr. Maiden, Government Botanist of New South Wales, informs me that it is a very common plant there in grass lands, and that the fruits are sweetish and are eaten by children under the name of "dumplings." He never heard of the plant being poisonous to man or beast, and there was no direct evidence in the cases I investigated to show that the weed was poisonous.

To get rid of the weed, simply as a weed, I recommended that badly-infested land be ploughed under and cropped, as land that has been so treated some years ago was evidently much less overrun.

Strawberry Plants Infertile. — Now and again strawberry plants are sent to me with the remark that they are suffering from some mysterious disease, which prevents them maturing their fruit. Now, the causes of the non-setting of

fruit may be various, but I generally find that in these cases sterility is simply due to imperfect or unisexual flowers. Thus, there are strawberry flowers which lack the pollen-producing apparatus or stamens altogether, while others have so few and so poor stamens that they are practically self-sterile. Of course, if the fertilizing element is not present, no fruit can be produced, and there should be at least one row of a perfect flower variety for every two rows of an imperfect variety.

This opens up a big question of great practical importance, for, in the case of other fruits, such as apple and pear, plum and cherry, &c., there are some varieties which are more or less self-sterile, and are either wholly or partially self-sterile, and are therefore either wholly or partially incapable of setting fruit when limited to their own pollen; while others are self-fertile, and may be grown by themselves. To make fruit-growing a commercial success, there are still a number of investigations to be carried out, on these and similar lines, as well as in the treatment of disease. I consider that there ought to be experiment orchards as well as experiment farms, where these and other matters affecting the fruit industry should be put to the test of practical experience, for I am a believer in this, that, whenever you can show the average fruit-grower results which will favorably affect the pocket, then you will require no Act of Parliament to enforce the adoption of the same methods.

REPORT OF THE CHIEF DAIRY EXPERT

(Robert Crowe.)

During the past year the nature of the work done by the dairy branch has been very varied. For the first half of the year the late Mr. D. Wilson directed operations. By his death the dairying industry lost an enthusiast who could be ill spared. From the inception of the co-operative factory system until his death Mr. Wilson was closely associated with the dairying industry, as the head of this branch of the department, and was the pioneer in the export trade of perishable products. Mr Wilson's great aim in life was the improvement of the condition of his fellow men, and in doing this he met with considerable success. The export trade in dairy and other perishable products was successfully launched under his supervision.

He studied patiently and overcame the first principles of success, and now his successors have more to do with the maintenance of a high standard of quality and improvement.

Mr. Potts deals with the details of his useful work for the year, under a separate heading.

My duties, for the first six months, consisted mainly in inspecting dairy produce for export, and advising and instructing manufacturers. As time permitted, I gave lectures on profitable dairying and dairy and factory management, to dairy farmers and factory and creamery managers in various parts of the colony. Factories, creameries, and dairy farms were also inspected.

In this way, 29 lectures were given, and 37 factories and creameries, and numerous farms, were visited.

For the last six months I was fully engaged in supervising the export business of the department at the City Freezing Works, and the colony's export trade in perishable products. In this work I was ably assisted by Mr. J. Wilson, in the dairy produce division, Mr. A. Hart in poultry and rabbits, and the other inspectors under the Exported Products Act. Experiments were carried out to a limited extent, and some progress made.

The volume of business done by the Department in preparing perishable produce for export during the past year has been greater than for any previous year in the history of this branch of the export trade. This satisfactory result is due to the favorable season experienced, coupled with the increased attention given by producers to the growth of dairy produce and mutton for export. The farmers have recognised that their hope in the future lies in the economical development of the colony's natural resources.

The following table represents only the surplus perishable produce prepared and exported by the Agricultural Department :—

PRODUCE EXPORTED THROUGH THE DEPARTMENT OF AGRICULTURE AT THE CITY FREEZING WORKS FROM 1ST JANUARY TO 31ST DECEMBER, 1899.

Description of Produce.	Quantities.	Approximate Value (c.i.f.).
		£
Butter	12,684 tons ...	1,268,400
Cheese	858 crates ...	2,574
Milk	3,797 cases ...	5,594
Pork	64 carcasses ...	128
Lamb and mutton	100,633 carcasses ...	50,316
Mutton (legs and pieces)	560	28
Kidneys and tails	100 lbs.	5
Beef	312 pieces ...	600
Veal	834 sides... ...	834
Poultry	214 packages ...	428
Game	5 packages ...	10
Eggs	44,220 dozen ...	1,842
Rabbits (furred)	1,675,632 pairs ...	125,672
" (skinned)	76,674 pairs ...	3,833
Hares	946 pairs ...	94
Fruit	8,849 cases ...	4,424
Tobacco	112,765 lbs. ...	1,827
Total approximate value		£1,466,609

The 12,684 tons of butter was made up of 11,595 sent to Great Britain, 1,022 to South Africa, 60 to West Australia, and 7 to Colombo. This was comprised of 9,355 consignments from the country, which consisted of 504,960 packages, and involved approximately 28,000 inspections.

Records were kept of the condition and quality of each consignment, with temperatures at time of arrival and before shipping. As far as opportunity permitted, factories sending butter below the average in quality were written to regarding faults, and remedies suggested, with generally satisfactory results.

Since the close of the year, a great deal has appeared in the daily and weekly press regarding the quality of Victorian export butter as compared with previous years. The controversy was started on account of the discrepancy between the prices of Danish best butter and those of best Victorian butter on the London market.

The Honorable the Minister of Agriculture has directed a Board to inquire into the matter fully, and, as a member of that Board, I feel debarred from saying anything here in regard to the subject. However, it is satisfactory to note that the dairymen of the colony have not suffered in prices during the past year as compared with the previous one. Most factories secured as high an average price in London, and as the dairymen supplied considerably more milk, the cost of manufacturing was slightly decreased. Consequently, a larger share of the selling value than usual was left to find its way into the producers' pockets.

The result is that the industry was never in a more flourishing state in the colony than at the present time ; dairy stock and land have increased considerably in value, and there is every prospect of much further expansion.

For the greater part of the year, the local market for cheese was glutted. Prices were maintained by simply holding back stocks, which gradually accumulated. The market was monopolized by those producers who could, on account of their geographical position, supply a good quality regularly. This left a number in out-of-the-way places with practically no outlet for their produce. In a certain district, not very distant from Melbourne, but at times almost inaccessible by road, the suppliers to a cheese factory were for nine months without pocketing a cheque for cheese.

Owing to their irregular deliveries, no customers could be found for their stocks at current prices, as the trade was fully supplied from regular sources. As the market in

England was good, a number of agents and manufacturers were encouraged to ship. Some reluctantly complied, remembering an unprofitable experience of a few years before.

A shipment was got together and sent away, which turned out satisfactorily. Others followed, and now it is reported that the local and export markets for cheese have not been in such a healthy state for years past.

The export trade in milk and cream is growing, and promises to expand into large dimensions.

Pork, a by-product of the dairy, is beginning to receive attention. Trial samples have been exported, and detailed information is at the moment awaited by the producers and the trade as to the prospects of developing an export trade in pork, hams, and bacon. The fact is becoming patent to all that the dairying industry is expanding, and that the breeding, rearing, and fattening of pigs is a necessary and profitable adjunct to the dairy. This branch or by-product of dairying will continue to expand with the industry, and has already outgrown the requirements of the local market.

Such being the case, there appears nothing to prevent prices from receding to an unpayable level unless an export trade in some form be developed. With a profitable outlet in this direction, a splendid field would be open for the extension of swine production.

Veal as an exportable commodity is also growing. However, only a limited trade is likely for some years to come, as a great percentage of calves are required to keep up and increase the dairy stock of the colony.

Poultry, game, and eggs are receiving more attention, and it is hoped that this branch of industry will be stimulated and developed on proper lines. An increased production of the right class of poultry is urgently needed. It has been sufficiently demonstrated that almost unlimited export markets exist, which are capable of absorbing more than this colony is likely to produce. This fact should encourage producers to give serious attention to the breeding of poultry for export. Mutton, lamb, and beef, &c., show a great increase, and as much attention is now given to the breeding and fattening of stock specially for export, considerable expansion will result in the future.

As a consequence of special breeding, it is worthy of note that the prices of Victorian mutton and lamb, as compared with that from other colonies and countries, show a tendency towards improvement. Many land-holders, and even dairymen, in the southern districts, are seriously contemplating combining the fattening, or rather the topping-off, of lambs and sheep for export, with a view to broadening their system of rotation of crops, and thus prolonging the fertility and usefulness of their land. As such feeding or finishing-off on special fodders will somewhat approach the system adopted with such great success in New Zealand, our lamb and mutton should more nearly resemble the quality which is so much appreciated by the British consumers, and a rise in values should result.

The trade in rabbits and hares has increased greatly, and there is every likelihood of a large business being done for many years to come. Of course, it would be more desirable to have the grass now consumed by bunny turned into dairy produce, beef, mutton, or wool, instead of rabbits; but the position has to be faced that the rabbits already exist in enormous numbers in various parts of the colony; they are prolific, and, so far, defy complete extirpation. They can be kept in check in thickly populated districts, but it seems an almost hopeless task to keep them in bounds in many outlying parts. Whilst Britishers continue to appreciate rabbit flesh, and we have it in such abundance, it would appear that the best thing to do with rabbits is to freeze them and send them along for consumption.

In the early part of the year some fruit—chiefly apples—was prepared for export by selecting, packing, and cooling before shipment. This method of treatment turned out a great success, and would have been followed up this season but for the comparative failure of the apple crop.

Although tobacco figures in the returns, it required no cooling, and was simply received and stored awaiting shipment.

Only a portion of the perishable exports of the colony is prepared at and shipped from the Government Freezing Works, hence it is necessary, in order to show the output of the colony, to take into account the quantities treated elsewhere. The following tables show the variety of Victorian perishable produce exported, its value and destination :—

VICTORIAN DAIRY PRODUCE EXPORTED FROM 1st JANUARY TO 31st DECEMBER, 1899.

(Compiled from returns of Customs Department.)

Countries to which Exported.	Butter.	Value (c.i.f.)	Cheese.	Value.	Milk and Cream.	Value.	Milk (concentrated).	Value.	Milk—Preserved.	Value.	Bacon.	Value.	Hams.	Value.	Pork, Fresh—(carcasses and sides).	Value.	Pork, Salt—(sides).	Value.	Gross Value of Dairy Produce Exported to each country.
	lbs.	£	lbs.	£	galls	£	lbs.	£	lbs.	£	lbs.	£	lbs.	£		£		£	£
United Kingdom ..	26,045,210	1,162,732	110,004	3,148	..	..	22,496	293	10,518	134	..	..	..	..	..	..	..	..	1,166,307
Cape Colony ..	2,245,560	100,221	17,647	494	..	..	3,972	54	..	..	2,532	83	1,786	58	10	5	14	29	100,944
Natal	1,659,740	74,095	44,085	907	280	28	161,024	2,009	2,240	28	34,991	1,095	7,523	234	..	..	..	..	78,396
West Australia ..	3,453,401	146,461	266,000	5,396	6,056	617	197,944	3,427	7,120	160	881,080	27,303	80,477	3,099	186	409	46	100	186,972
New South Wales ..	1,217,619	51,643	132,137	2,904	16,183	1,835	5,100	69	5,768	121	146,264	4,824	5,509	210	3	5	..	..	61,611
South Australia ..	676,531	28,692	37,341	771	32,319	3,832	23,506	429	23,550	503	5,314	139	278	9	3	3	52	63	34,441
Tasmania	368,224	15,617	13,805	255	30	4	10,436	183	2,786	56	41,620	1,304	3,327	114	..	..	10	19	17,552
Queensland ..	2,460	124	680	22	..	..	..	..	..	..	1,138	40	..	..	..	..	..	..	186
New Zealand ..	325	16	20	1	..	..	..	..	..	..	80	3	..	..	..	..	..	..	20
Aden	2,200	110	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	110
Burmah	1,544	70	82	2	..	..	..	..	..	..	..	..	..	..	..	..	..	..	72
China	604	29	483	10	..	..	..	..	..	..	..	..	..	..	..	..	..	..	39
Hong Kong ..	113,560	5,476	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	5,476
Cochin China ..	600	30	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	30
Egypt	500	25	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	25
Fiji	16,968	828	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	828
Guam	5,752	253	851	19	..	..	46	2	..	..	724	25	471	19	19	42	..	..	360
India—Bengal ..	5,232	262	1,505	38	..	..	..	..	..	..	424	13	274	11	..	..	2	4	328
,, Bombay ..	1,284	64	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	64
,, Ceylon ..	83,238	3,862	35,990	877	..	..	..	..	..	..	93	7	219	11	..	..	..	..	4,757
,, Madras ..	6,187	315	4,689	103	..	..	..	..	..	..	..	..	..	..	..	..	..	..	418
Japan	100	5	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	5
Java	127,322	6,193	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	6,193
Malden Island ..	100	5	19	1	..	..	..	..	..	..	131	5	..	..	..	..	..	..	11
Malta	500	25	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	25
Mauritius ..	6,428	321	560	14	..	..	..	..	..	..	400	15	..	..	..	..	..	..	350
Phillipine Islands ..	14,860	756	120	3	..	..	56	1	5,600	88	30	1	1,055	40	..	..	..	..	889
Sandwich Islands ..	17,304	832	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	832
Siam	2,100	98	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	98
Straits Settlements	159,332	7,819	5,621	150	..	..	..	..	..	..	94	4	..	..	..	..	..	..	7,973
Thursday Island ..	2,684	137	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	137
Totals ..	36,237,469	1,607,096	671,639	15,115	54,868	6,316	424,580	6,467	57,562	1,090	1,114,915	34,861	100,919	3,805	221	464	124	215	1,675,429

VICTORIAN MUTTON, RABBITS, ETC., EXPORTED FROM 1ST JANUARY TO 31ST DECEMBER, 1899.

Countries to which exported.	BEEF, MUTTON, AND LAMB.						
	Frozen Beef.	Value.	Frozen Mutton and Lamb.	Value.	Preserved Meats.	Value.	Gross Value of Meat and Mutton exported to each Country.
	Centals.	£	Centls.*	£	lbs.	£	£
United Kingdom ..	23	28	75,423	75,496	261,487	3,774	79,298
Cape Colony ..	943	1,123	2,054	1,947	323,498	5,794	8,864
Natal	337	437	5,034	5,125	71,846	1,365	6,927
West Australia ..	330	390	843	987	93,130	2,761	4,138
New South Wales ..	..	..	..	..	15,770	399	399
South Australia ..	..	..	36	48	4,749	99	147
Queensland ..	..	..	..	..	474	9	9
Tasmania	..	..	..	..	17,800	357	357
Hong Kong ..	..	..	..	..	528	8	8
Egypt	..	..	565	506	..	..	506
Guam	..	..	..	..	96	3	3
India—Bengal ..	..	..	..	..	248	22	22
,, Ceylon ..	..	..	..	..	4,630	92	92
,, Madras ..	..	..	..	..	192	3	3
New Hebrides ..	.	..	..	..	27	1	1
Straits Settlements	..	..	..	..	576	23	23
Thursday Island ..	..	..	..	..	480	12	12
Totals ..	1,633	1,978	83,955	84,109	795,576	14,722	100,809

* There are about two carcasses in each cental (100 lbs.).

VICTORIAN RABBITS, ETC, EXPORTED—*continued.*

Countries to which Exported.	RABBITS AND HARES, POULTRY AND EGGS.								
	Rabbits and Hares Frozen.	Value.	Rabbits Preserved.	Value.	Poultry and Game.	Value.	Eggs.	Value.	Gross Value of Rabbits and Poultry exported to each Country.
	Pairs.	£	lbs.	£	Packgs.	£	Gross.	£	£
United Kingdom ..	2,333,046	145,815	3,713,468	32,109	116	232	3,674	1,837	179,993
Cape Colony ..	4,095	256	141,056	1,771	854	1,708	..	..	3,735
Natal	3,656	229	45,024	615	224	448	466	233	1,525
West Australia ..	7,175	448	27,224	356	417	834	1,855	1,236	2,874
New South Wales ..	3,948	247	16,992	316	..	..	741	390	953
South Australia ..	..	..	288	4	..	..	..	..	4
Queensland ..	576	36	288	2	..	..	..	.	38
Tasmania	..	..	13,195	185	4	9	100	63	257
New Zealand ..	..	..	..	..	..	..	5	7	7
China	..	..	96	3	..	..	..	..	3
Hong Kong ..	..	..	..	..	4	8	..	..	8
Guam	..	..	96	2	..	..	3	2	4
India—Bengal ..	..	..	1,056	14	..	..	..	..	14
,, Ceylon ..	800	49	3,096	44	22	56	..	..	149
Malta	..	..	..	..	4	8	..	..	8
Phillipine Islands ..	..	..	2,400	28	..	..	..	..	28
Straits Settlements	..	..	192	3	..	..	..	..	3
Totals ..	2,353,296	147,080	3,964,471	35,452	1,645	3,303	6,844	3,768	189,603

NOTE.—In addition to the above, there were 16,444 centals of Beef, value £20,024; 152,622 centals of Lamb and Mutton, value £145,425; and 299,969 lbs. Preserved Meats, value £6,028—the produce of New South Wales, exported from Victoria.

VICTORIAN FRUIT EXPORTED FROM 1st JANUARY TO 31st DECEMBER, 1899.

Countries to which Exported.	Fresh. Unclassified.	Value.	Oranges.	Value.	Lemons.	Value.	Dried. Unclassified.	Value.	Bottled and Canned. Unclassified.	Value.	Currants. Dried.	Value.	Raisins. (Sultanas) Dried.	Value.	Raisins (other). Dried.	Value.	Gross Value of Fruit Exported to each Country.
	Bushs.	£	Bshls.	£	Bshls.	£	lbs.	£	Doz. pts.	£	lbs.	£	lbs.	£	lbs.	£	£
United Kingdom ..	9,608	3,792	..	..	..	..	3,594	103	2,205	374	..	..	..	..	28	1	4,270
Cape Colony ..	256	101	..	..	..	..	620	13	692	140	..	..	..	..	..	..	254
Natal	2,117	705	..	..	..	..	200	4	49	10	..	..	..	..	..	..	719
West Australia ..	340	131	4,300	1,247	969	293	30,556	705	28,443	5,710	3,000	25	..	..	30,939	442	8,553
New South Wales ..	95,433	19,582	227	81	52	18	269,771	4,978	7,366	1,447	..	..	56	1	172,656	2,729	28,836
South Australia ..	88	48	1,684	615	420	165	5,684	139	138	19	..	..	..	..	..	..	986
Queensland ..	7,806	1,252	50	22	..	..	69,979	1,623	1,272	254	..	..	..	..	69,928	1,002	4,153
Tasmania	9,369	3,057	153	67	563	170	6,569	145	203	8	..	..	..	..	23,760	362	3,809
New Zealand ..	3,144	1,278	1,180	393	503	173	14,178	281	171	20	..	..	..	..	224,390	2,892	5,037
Burmah	..	..	..	..	..	..	80	3	374	74	..	..	..	..	..	..	77
China	..	..	..	..	..	..	..	..	21	4	..	..	..	..	..	..	4
Fiji	..	..	..	..	..	..	..	..	295	62	..	..	..	..	..	..	62
Germany	..	..	..	..	..	..	5,540	97	49	11	..	..	..	..	..	..	108
Guam	..	..	..	..	..	..	1,482	43	159	38	..	..	..	..	700	27	108
Hong Kong ..	..	..	..	..	..	..	..	..	125	18	..	..	..	..	..	..	18
India—																	
Bengal	163	43	..	..	..	..	40	1	1,022	206	..	..	..	..	..	..	250
Bombay	225	93	..	..	..	..	..	..	..	..	..	..	..	..	..	..	93
Ceylon	1,506	425	..	..	..	..	1,736	37	1,971	392	..	..	109	2	2,834	66	922
Madras	..	..	..	..	..	..	2,990	71	8	3	..	..	..	..	..	..	74
Java	453	148	..	..	..	..	508	13	4,323	865	..	..	..	..	..	..	1,026
New Caledonia ..	..	..	..	..	..	..	..	..	7	1	..	..	..	..	..	..	1
Phillipine Islands ..	..	..	..	..	..	..	..	..	7	1	..	..	..	..	..	..	1
Straits Settlements	104	52	..	..	..	..	..	..	..	..	..	..	..	..	..	..	52
Thursday Island ..	127	31	..	..	..	..	140	5	73	15	..	..	..	..	..	..	51
Totals	130,739	30,738	7,594	2,425	2,507	819	413,667	8,261	48,973	9,672	3,000	25	165	3	525,235	7,521	£59,464

SUMMARY of Victorian Perishable Products Exported from 1st January to 31st December, 1899.

Value of Dairy Produce	£1,675,429
" Rabbits, &c.	189,603
" Mutton, &c.	100,809
" Fruit, &c.	59,464
Total Value of Perishable Products exported for year	£2,025,305

DAIRY ECONOMICS.

Reducing Cost of Production.

The permanence of dairying in Victoria depends more on the net return secured by dairymen from their cows than on any or all the other features of the industry. There is, generally speaking, greater scope for increasing the returns by judicious breeding, selection, feeding and management of dairy cattle than in all the after processes of manufacturing and marketing. If the dairymen of the colony were offered perfect factories and creameries free of cost, labour, management, materials, expense of freight, handling and marketing gratis, and guaranteed the highest prices in the London market, the aggregate concessions would not amount to what might be secured by closely studying and practising economical dairy management. Every dairyman should record the quantity and quality of milk given by each cow in his herd. By this means he will be enabled to take sure steps towards reducing the cost of production of each pound of butter, and insure success in his competition in the markets of the world.

The following table contains a few of the many lessons which may be learned by studying dairy cows :—

A COW STUDY.

Three Years Milk Returns from a Herd of Twenty Cows.

Cows.			1897.				1898.				1899.				Averages.				
No.	Names.	Present Ages.	Gallons of Milk.	Test.	Lbs. of Butter.	Months Milking.	Gallons of Milk.	Test.	Lbs. of Butter.	Months Milking.	Gallons of Milk.	Test.	Lbs. of Butter.	Months Milking.	Gallons of Milk.	Lbs. of Butter.	Value at 8d. per lb. £	s.	d.
1	Spot	9	630	4·2	295	11	666	4·2	312	10	801	4 2	375	11	699	327	10	18	0
2	Lily	13	509	4·6	263	10	609	4·6	315	9	621	4·6	321	9	579	299	9	19	4
3	Fanny... ...	12	575	4·0	255	9	632	4·0	280	9	792	4·0	351	8	666	295	9	16	8
4	Lottie... ...	12	683	3·6	271	10	692	3·6	275	10	750	3·6	298	9	708	281	9	7	4
5	Bawley ...	8	619	3·6	246	12	671	3·6	266	10	830	3·6	330	12	706	280	9	6	8
6	Bess	10	531	4·5	268	8	524	4·5	264	9	505	4·5	255	9	520	262	8	14	8
7	Flo	8	697	3·3	252	11	598	3·3	216	8	835	3·3	302	11	710	256	8	10	8
8	Snaily... ...	7	521	4·0	231	12	557	4·0	247	9	621	4·0	275	9	566	251	8	7	4
9	Blossom ...	8	666	3·2	233	9	514	3·2	180	8	898	3·2	314	11	692	242	8	1	4
10	Polly	14	587	3·6	233	11	445	3·6	176	10	674	3·6	267	11	568	225	7	10	0
11	Mary Ann ...	11	662	3·3	239	10	714	3·3	258	11	478	3·3	173	9	618	223	7	8	8
12	Bunny ...	6	430	3·9	186	10	471	3·9	193	9	668	3·9	288	9	523	222	7	8	0
13	Liz	11	399	3·8	168	10	653	3·8	275	9	513	3·8	215	9	521	219	7	6	0
14	Dolly	7	421	3·8	177	10	420	3·8	176	10	695	3·8	292	11	512	215	7	3	4
15	Judy	7	502	3·8	211	10	358	3·8	151	8	670	3·8	282	10	510	214	7	2	8
16	Princess ...	7	409	3·7	167	9	532	3·7	217	7	620	3·7	253	9	520	212	7	1	4
17	Violet ...	11	359	3·8	151	6	612	3·8	257	10	492	3·8	207	7	487	205	6	16	8
18	Cherry ...	7	375	4·0	166	10	456	4·0	202	8	550	4·0	244	9	460	204	6	16	0
19	Nelly	8	471	3·2	165	9	478	3·2	167	8	680	3·2	238	8	543	190	6	6	8
20	Redmond ...	7	365	3·6	145	11	369	3·6	146	8	512	3·6	203	9	415	164	5	9	4
	Averages	...	520	...	216	...	548	...	228	...	660	...	274	...	576	239	7	19	6

All the milk from each cow was weighed and recorded after milking.

The cows were crossbred, with the Shorthorn breed predominating, and are now breeding to a pure Ayrshire bull.

It should be understood that the tests were properly recorded for the year 1897 only. The same tests are attached to the following two years' returns, in order to present them in a more complete form.

Tests of the milk were made and recorded for the months of November and December, 1899, but they showed much higher than the averages here quoted—probably on account of the advanced period of lactation at which the cows were at the time. Needless to say that the table would have been much more valuable had the actual quality of the last two years' milk been shown.

Only the cows that were milking for the three years running are included in the above table. For the year 1897, a total of 32 cows were milked for an average return of 520 gallons. For 1898, 34 cows for an average of 500 gallons, and 1899, 38 cows for an average of 579 gallons.

The falling-off in the average of 1898 may be explained by the introduction of a number of heifers to replace some old or inferior cows, and to the season.

Taking the averages as shown for the three years, it is found that the ten best cows yield an average of 641·4 gallons of milk, containing 271·8 lbs. of butter, worth at 8d., £9 1s. 2d. per head.

The other ten cows give an average of 510·9 gallons, containing 206·8 lbs. butter, worth at 8d., £6 17s. 10d. per head per year.

Assuming that it costs £4 for the yearly keep and attention of each cow, the worst gives an average profit per year of £1 9s. 4d., and the best £6 18s., or 4⅔ times as much. The total average profit per year from the three worst cows amounts to £6 12s., or 6s. less than that from the best cow, thus clearly showing that "one good cow is worth more than three ordinary ones."

Taking the returns of Nos. 2 and 7 cows, No. 2 gives an average of 579 gallons, worth £9 19s. 4d., and No. 7, 710 gallons, worth £8 10s. 8d., or £1 8s. 8d. less. If it were

worth the same rate per gallon as that from No. 2, it would have brought £12 4s. 5d., or 43 per cent. more, but against that the table indicates that the deepest milkers were invariably the best cows.

The whole herd of cows was fed and treated alike. No artificial food was given beyond a few bags of small potatoes for a short period. They had access to straw stacks at all times. The large increase in the 1899 returns is attributable to the good season mainly, or, in other words, to better feeding. To a less extent improved management is responsible for some of the increase.

The greatest and most valuable lessons to dairymen in those records are, first, that it pays best to keep good cows; second, having good cows, nature has here illustrated that it pays to feed them well at all times; and, thirdly, that it pays to weigh and test the milk from each cow, and record same, as it serves as a certain guide to further improvement.

A SIMPLE METHOD OF PREPARING A PURE STARTER FOR CREAM RIPENING.

(*By A. N. Pearson, Chemist for Agriculture, &c.*)

This method is based on the fact that the favorable bacteria in milk grow more rapidly at certain temperatures than the unfavorable ones. If a drop of cream from the ordinary ripening vat of a factory be taken, it would contain a certain number of favorable lactic acid bacteria and a smaller number of unfavorable ones ; it might be in the proportion of, say, twenty favorable ones to one unfavorable one. If this drop were sown in a small quantity of sterilized milk, and this milk were kept for some time at a temperature favorable to the rapid growth of desirable bacteria and unfavorable to the undesirable bacteria, the desirable bacteria would multiply more rapidly than the others ; they might multiply 1,000-fold, while the others multiplied only 100. They would then be in the proportion of 20,000 of the favorable and only 100 of the unfavorable ; that is to say, of 200 to 1.

If this sample of milk were kept at that temperature long enough, the favorable bacteria would grow until they had used up all their food ; their growth would then cease, and then the unfavorable ones would have the field left to themselves, and in the end these would liquify and decompose the curd, destroy the favorable bacteria, and produce a foul-smelling mass.

If, before this destructive process commenced, a small drop of the milk containing the bacteria in the proportion we have for illustration assumed as 200 favorable to 1 of unfavorable, were taken and sown in another small flask of sterilized milk, which again was kept for the required time at the suitable temperature, the favorable bacteria would again rapidly multiply, so that the proportions would be as 200,000 to 100, or 2,000 to 1. By repeating this operation a third time, the proportion would become 20,000 to 1, and, after one or two more such operations, the unfavorable bacteria would be reduced to such small numbers that a single drop taken out of the flask would in all probability contain no unfavorable bacteria. Such a drop sown in a quantity of sterilized milk would produce a culture consisting of nothing but favorable bacteria. Such a culture would not, in the strict sense

of the term, be a "pure" culture, which means a culture of only one species of bacterium ; but the culture produced by the above method would contain probably three or four species. It is likely, however, that it would have an advantage over a single species culture, for the reason that it would combine the beneficial aspect of a number of species. If the cream originally taken were a mixture of samples from three or four factories which had the reputation of producing uniformly good-quality butter, there is a probability that the ferment thus obtained would be a select one.

The method is so simple and so easily carried out, that some factory managers could, without difficulty, carry it out.

The first step is to get a number of small bottles containing sterilized milk. The best way is to prepare 50 or 100 of these at once ; small two-ounce bottles will serve the purpose. Rinse them out with some dilute sulphuric acid (about one of acid to ten of water), then with some hot soda, and then three or four times with freshly-boiled water ; then turn them upside down to drain, in a basket made of smallest meshed wire netting, or of perforated galvanized iron. Take them to a small operating room, which can be easily built up against some window, and which may be about 6 feet square, and should be closed by a door, so as to keep the place free from dust. The room should have a broad shelf in front of the window, and one or two shelves on the walls, and may have a wooden stool to sit on. The walls, ceiling, floor, shelves, and stool should be frequently washed with lime-water, and the place kept scrupulously clean for operations of this kind. It is best to work in it without a coat, and with bare arms, or with a clean white coat kept just for the purpose, as an ordinary coat makes too much dust. Before working in the room, the hands should be well washed in recently-boiled water, and finally rinsed in a weak disinfectant fluid, such as lime-water. It is a good plan to have a spirit lamp burning in the operating room, and to occasionally pass the fingers through the flame.

Take the basket of freshly-washed bottles into this room, and there put into them stoppers of best surgical cotton wool ; the stoppers being formed by tearing off a sufficient amount of the cotton wool, and tightly rolling it into a little plug. The next step is to sterilize the bottles. This may

be done by suspending the basket containing the bottles in some suitable vessel, such as an old nail-can, having a hole in the lid and also in the bottom. Place this over the steam jet, so that the jet shall pass through the bottom hole, turning on the steam gradually, so as not to crack the bottles, and leave it on the jet for an hour. The nail-can or other vessel will be improved if it be covered on the outside with felt, or three or four thicknesses of flannel or woollen cloth.

Take the bottles to the operating room, where a pint or quart of freshly-skimmed milk may be boiling above the spirit lamp. Take a clean, dry, babcock pipette, and pass it a few times backwards and forwards through the flame of the spirit lamp, until it is hot enough to kill all germs on it; then put a pipette full of the hot milk into each bottle. The fingers should, before this operation, be passed through the flame a few times, so as to kill the germs on them. The cotton-wool plug should be removed from the bottle by the finger and thumb, and held by the finger and thumb of one hand while the pipette is being emptied into the bottle with the other hand, and should then be immediately replaced. Be careful not to let the milk wet the inside of the neck of the bottle. Carry out the operation as expeditiously as possible.

The next operation is the sterilizing of the milk in the bottles. For this purpose, the basket containing the bottles with the milk is again placed in the nail-can—which we may call the steam sterilizer—and this placed over the steam jet for an hour, the steam being turned on gradually as before, so as not to break the bottles. At the end of the hour the sterilizer is replaced in the operating room, and kept there till the next day, when the steaming is repeated for half-an-hour, and again on the third and on the fourth day. The milk will be then quite sterile, and, if the cotton-wool plugs are right, and no milk has been allowed to wet the necks of the bottles, will, if the bottles be kept in a dust-free box, remain sterile indefinitely, and will be ready for use whenever wanted. As an additional precaution, they may be kept in the cool room.

To sow the bacteria in these bottles, take the sample of selected cream—if no special cream is desired, or obtainable, take a little of the best cream available in the factory—into the operating room; then, with the hands cleaned as before

stated, and the fingers finally passed through the spirit-lamp flame two or three times, take one of the bottles, and pass the mouth of the bottle a few times through the flame, so as to singe the cotton wool, thus killing any microbes that may have lodged on the outside of the cotton wool and on the mouth of the bottle. Then take a piece of platinum wire about 6 inches long and the thickness of a darning needle, which should be stuck into a small cork, or, better still, fused into a bit of glass tube to serve as a handle. Make this platinum wire red hot in the flame, then dip about half-an-inch of the end of it into the cream, quickly remove the cotton-wool plug from the bottle, and immediately dip the platinum wire into the milk in the bottle, taking care not to smear the neck of the bottle; stir it round once or twice, withdraw it, and immediately replace the cotton-wool plug. That finishes the operation of sowing the bacteria in the milk. The next operation is to keep the milk at the favorable temperature for six or eight hours. This temperature is between 80 deg. and 90 deg. Fahr. In summer the air of the room may be at this temperature, or a place in the boiler-room may be found where the temperature remains pretty constant at this degree. If such be the case, all that is necessary is to put the bottle in a clean box or can, so as to protect it from the light and the dust, and put it in the chosen place for six or eight hours. If this is not the case an incubator will be necessary. This can be simply a can of about one or two gallons capacity, filled with water of the desired temperature, and suspended or placed on a stand above a kerosene lamp with a small flame, previously regulated to such a size that it will keep the water at the desired temperature. The bottle should be placed in a small can, and suspended in this water. After six or eight hours, another bottle is to be inoculated from this bottle, just as this bottle had been inoculated from the cream, using all the precautions as before, and singeing the cotton wool of both bottles before opening them. During the night, if it is not convenient to attend to the operation, the bottles may be kept in ice, or in the cool room, and the work commenced again next morning. Repeat this operation at least six times. Keep all the bottles at the favorable temperature till the milk in them coagulates to a jelly. After that, they may be kept in the box on the shelf of the operating room for a few days. In the first a change will be observed after

a few days, the curd becoming liquid, discoloured, and stinking. In the second bottle this change will not occur till later ; in the third it will be much later, and in the fifth and sixth bottles, if things have been done well, it will not occur at all ; the milk will remain indefinitely in a jelly, which, when the time comes for opening the bottle, will be found to have a sweet nutty flavour.

The contents of this bottle may be emptied into a gallon of sterilized milk, and this, having been kept at 80 deg. or 90 deg. for 24 hours, or until coagulated, may be used for preparing the starter in the usual way. It is not to be expected that all, or even many, factory managers will be able to carry out this process, but some undoubtedly would. The description here given has been lengthy, because minute details have been entered into, so as to avoid possibilities of error. But the process is not nearly so formidable as so long a description would at first sight make it appear. After two or three trials, it will be found comparatively simple ; and those who are able to try it will, in the end, find it not only immediately profitable and useful, but also highly interesting and instructive ; showing them, by practical demonstrations in their own hands, the effects of the various microbes in cream, even in what is commonly considered good cream. Those subsequent, putrescent, and ill-flavoured changes that go on in the ferment bottles, after the coagulum has been formed by the first lactic ferment, are changes which would take place in the butter itself on long keeping, if some means of preventing or checking them were not adopted.

REPORT BY A. A. BROWN, M.B., B.S.

Export of Meat, etc.

During the year 1899, 307,065 carcasses of mutton and lamb were frozen for export at Messrs. John Cooke and Co.'s and at the Government Freezing Works. Of this number, Messrs. John Cooke and Company exported 138,807 sheep and 68,887 lambs. The quality of the consignments that left Melbourne was all that could be desired. Last year, speaking generally, sheep came down from the stations in splendid condition, and, when it is considered that no special efforts are made to prepare sheep for slaughter for export, our exporters deserve high commendation for their exertions in selecting the choicest sheep on stations for their trade. The time is not far distant when sheep will be specially reared for export. Over and above the numbers quoted, 2,154 sheep and lambs were rejected for export for various reasons. There were also exported 369 bodies of veal, 17 carcasses of pork, 550 legs and 125 saddles of mutton, 160 bodies, and 28 other pieces of beef, 32 ox tails, 96 ox tongues, as well as a large number of sheep kidneys. No complaints as regards inferior quality, nor as regards bone-taint, were made last year about Victorian shipments at the ports of Europe or Africa, to which they were consigned. Messrs. John Cooke, William Anderson, Thomas McFarland, and the Fresh Food Company, our largest exporters of meat from the port of Melbourne, endeavour to ship only prime carcasses, and no trouble is experienced in getting them to otherwise deal with carcasses unsuitable for export.

In 1898 there were shipped from Melbourne to Europe and Africa 163,417 sheep and lambs, of which number Messrs. John Cooke and Co. supplied 137,523; and in 1897 there were shipped 196,623 sheep and lambs, of which Messrs. Cooke and Co. supplied 117,849. Victoria is building up an excellent reputation for its lamb trade, and there is in London a demand for Victorian lambs that cannot yet be met, in consequence of short supplies at this end.

Our trade in frozen mutton is steadily on the increase, and with the advantages of the increased freezing accommodation about to be provided at the Government works, it is expected that the trade will still further expand. Although the number of sheep and lambs exported during 1899 was far in

excess of previous years, the number might yet have been greater had there been further freezing accommodation at the Government works. Exporters finding that accommodation was so uncertain, refrained many times on that account from buying up sheep which they could have secured at considerable advantage to themselves. It is expected now, however, that the Hon. George Graham, Minister of Agriculture, has decided upon increasing the freezing space that no check to the export of mutton will again occur, unless of course the trade inordinately increases. Mr. Wm. Angliss has just about completed extensive freezing chambers at his premises in Bourke-street, and exporters are now availing themselves of the space that he has at command to freeze their produce. These chambers, along with those at the Fresh Food Stores, should relieve, in future, congestion in the trade.

Through the instrumentality of the Department, a stimulus has been imparted to our tinned meat trade. At the outbreak of hostilities between Great Britain and the Boer republics the War Office authorities were informed that Victorian preservers could supply, for the use of the troops, large quantities of tinned beef and mutton, and there promptly came orders for goods of the kind mentioned to be despatched to Africa.

Up to the end of December last, 154,416 tins, each containing 2 lbs. of meat had been sent, and up the end of February last 321,508 tins had been consigned.

It is expected that the army authorities will favour the colony with many future orders, and there is every likelihood of there being established a permanent trade in tinned goods for use among the troops. The export of frozen rabbits and poultry has now been established on a permanent basis, and every precaution at the port of Melbourne has been taken to prevent the shipment of inferior products. No rabbits, unless of approved quality, are allowed to be sent from the Government works, and Mr. John Cooke was just as particular at his works in maintaining a high standard of quality. The rabbit trade has grown to prodigious proportions, and, from the Government chambers alone, something like 1,680,000 pairs of rabbits and 3,000 pairs of hares were frozen for export during 1899 ; and Messrs. John Cooke and Company exported something like 252,000 pairs of rabbits from their works. The poultry trade has not yet assumed very great

proportions. This, however, is an industry that requires fostering, and it ought to be a very profitable one. Producers have, however, to learn what kind of bird to breed for export, as no ordinary barn-yard fowl is fit for the trade.

Trial consignments of pork have, during this year, been sent to Africa, and it is expected that a flourishing trade in this commodity will be established, not only with African but also with European ports. If a large trade in pork be opened up, a valuable adjunct to dairy farming will be created.

An enormous number of rabbits annually come into the markets, and, from this number, the rabbits suitable for the frozen trade are selected. The rejects either find their way into local trade requirements or into the tinning factories. Any that are found unfit for human food are condemned under the provisions of the Health Act, and, as far as possible, every care is taken to prevent the use in any way of unwholesome rabbits. The trade in tinned rabbits is one deserving of special attention, from the many causes that operate to destroy its existence on a permanent footing. To improve this industry, and to erect it on a substantial foundation, there really is only one safe course to pursue, and that is to prohibit the tinning for export of any rabbits during the months of December, January, and February. By the time rabbits are transported from one theatre of commercial operation to some other, and ultimately to the tinning factory during these months, they are not then in a fit state to be preserved. Vigilant efforts have been exerted to stop the tinning of unsound rabbits, but the means to effectually suppress such an unsatisfactory trade lie in adopting the measures indicated.

Large numbers of rabbits are annually condemned as unfit for food for various reasons. Rabbits diseased with hydatids are always condemned. Apart from the question of disease altogether, large numbers suffer condemnation through having undergone putrefactive changes, and I have no hesitation in saying that much of this loss might be averted, if ordinary precautions in methods of treatment were adopted in the field by the trappers. A pamphlet dealing with the question has been published, under the auspices of the Department, and if the rules there laid down be adhered to, much of the loss that is now sustained will be prevented. Putrefaction is dependent upon the vital activity of germs, and it cannot

occur in their absence. Germs exist everywhere in nature, so, under ordinary conditions, no carcass can be kept free from them. Their growth, however, can be held somewhat in check by the adoption of proper precautions.

By carefully draining the carcasses of rabbits of blood, the flesh is enabled to keep longer, and, moreover, the delicacy of flavour is improved. The method of disembowelling is very important. Rabbits should not be taken from the traps, killed, and thrown into heaps, to there lie some considerable time before being disembowelled. They should be gutted within six or seven minutes after death. After having been gutted, they should be hung for a while across beams or branches of trees. They should be hung in the shade, and in such a way that air gets a free circulation around individual members. There they should be left until they set firm. If rabbits are stacked in heaps immediately after having been killed, the animal heat does not get a chance to dissipate, and consequently putrefaction (sweatiness), having all the elements to favour it, soon sets in. Under certain circumstances, the use of a little of a solution of boric acid and salt is justified. A little of the solution is sprinkled over the rabbits, and it prevents rapid putrefactive changes from setting in. Rabbits must be forwarded to market as soon as possible after slaughter. They are worthless if subjected to long detention.

Bone-taint.

That bugaboo of meat exporters and shipping and insurance companies—bone-taint—is not now heard of in carcasses shipped from Melbourne under supervision. By the kindness of Mr. John Cooke, who furnished the material, I conducted experiments into the occurrence of bone-taint.

It may at once be stated that bone-taint is a condition occasioned by the vital activity of putrefactive micro-organisms. Putrefactive organisms have reached the seat of the change, and, by their growth, they produce chemical alteration in the constituents of the meat, imparting to it a disagreeable taste and offensive odour. Decomposition brings about chemical changes and renders meat moist and soft. An acid—sarcolactic—is formed during the process, and it acts upon the connective tissues, rendering them soft and pulpy. Cold, although producing no chemical alteration, produces a physical change in meat. It retards coagulation of muscle plasma, that is, it checks *rigor mortis*. The

phenomenon of *rigor mortis*, or *post-mortem* stiffening, does not occur in a carcass when it is placed immediately after slaughter in a chamber, the temperature of which is below freezing point of water. After thawing, however, *rigor mortis*, which may have been long inhibited, occurs. After having been frozen and then thawed, the tissues loosen. The carcass of a recently slaughtered animal, placed under suitable conditions in a cold chamber, can be kept there indefinitely without decomposition setting in, so long as a sufficiently low temperature is constantly maintained. In cases of bone-taint where the taint was detected in carcasses after thawing, the meat had commenced to undergo putrefactive change, or to go bad as it is popularly termed, before having been subjected to the process of freezing. Cold arrests putrefaction, but does not destroy it. Then, as soon as the meat is removed from the influence of the cold chamber and thawed, and kept at ordinary temperature of atmosphere, putrefaction, which may have been arrested for months, again begins and progresses more and more. Bone-taint cannot be created by the processes of freezing, as some people imagine. If the carcass be perfectly sound and wholesome, when placed in the freezing chamber, then, no matter what length of time it is kept there at a low temperature, it will, when thawed, be found to have suffered no deterioration. Bone-stink is preventible. In hot weather carcasses should not be left to hang too long in an ordinary exposed hanging-room. They should, after slaughter, be conveyed to a chilling room, where a temperature of between 50° and 60° Fah. is maintained, until the animal heat has been dissipated. It is during the chilling processes that the myosin coagulates—that is *rigor mortis* occurs—and myosin then cannot well be pressed out of the sarcolemmæ (muscle sheaths) unless they be ruptured.

After *rigor mortis* has occurred, that is when the carcasses have set firm, they should be transferred to the freezing chambers where the temperature should be gradually lowered to 20° Fah. or further. An impression exists in the minds of some that bone-taint is caused by the exterior portions freezing suddenly and enclosing a less frozen internal zone. This idea has no foundation in fact, as the internal portions in carcasses of mutton and beef are hard frozen.

Bone-taint is not a result of freezing processes. It is occasioned by germs that had invaded the tissues before freezing commenced.

Carcasses of mutton, immediately after slaughter on a very hot day, were placed in the freezing chamber at a temperature of 10° Fah. and there kept three months. When thawed, the carcasses were cut up into quarters and a blood-stained fluid exuded from the cut surfaces. There was no taint. The aroma and colour was that of freshly killed meat. *Rigor mortis* set in after the carcasses thawed. Myosin and serum albumen existed in the blood-stained fluid that escaped from the cut surfaces. No ruptures in the sarcolemmæ (muscle sheaths) could be detected by the microscope.

Fruit Preservation.

The inhibition of the ripening of fruits for such time as will permit of their transport in a fresh state from Australia to the markets of Europe is a scientific problem of stupendous moment. Fruits must attain a certain degree of ripeness before being picked from the trees otherwise their flavour is vitiated and their value depreciated. Ripening is a chemical alteration in the constituents of fruit, and if this process can be arrested for a sufficiently lengthy period, so as to be of commercial application, then the problem is solved.

When fruit is varnished, ripening is checked, but commercial success is not to be achieved by this procedure. Fruits can be kept from decaying by being packed in vessels containing nitrogen. As fruit ripens, sugar rapidly forms, the acid constituents quickly combine with the alkaline and so diminish acidity. Ripening processes go on continuously up to a certain limit, and then the fruit begins to decay from further oxidation dependent upon bacterial influences.

Experiments were conducted in the early part of the year, following upon others that had been carried out previously, to devise means whereby soft and other fruits could be transported in a fresh state to the markets of Europe. The question of the preservation of fruits must be viewed from both bacteriological and carpological stand-points. Fruits formed from the ovary, bracts, and calyx, such as those of the hazel and the oak, can be kept almost indefinitely; fruits formed from the ovary and calyx, such as those of the apple, pear, and gooseberry, can, speaking generally, be kept long enough to suit the requirements of exporters ; whilst fruits formed from the ovary alone, such as those of the plum, cherry, grape, peach and apricot, cannot long be kept from decaying, except under great difficulties.

The method I employed in my experiments, was to keep the fruit in a chamber at a uniform temperature of 40° Fah., with a current of cold dry air constantly in circulation through it. Cold dry air in motion is an essential factor, as in moist stagnant atmospheres moulds readily develop. Fremy, in his celebrated experiments, showed that fruits covered with varnish do not ripen, but fruits so treated could not be profitably exported. Taking advantage of what Fremy taught, and what I confirmed, I wrapped the fruits in my experiments in absorbent paper for various reasons.

(1) To inhibit, in slight degree no doubt, the ripening process.
(2) To absorb moisture which is given off by the fruit in the process of ripening.
(3) To prevent spread of decay from unsound to sound fruit.
(4) To act as a padding to prevent bruising during handling.

Apples (Gravenstein variety) were kept twelve months ; pears, seven weeks ; peaches, nine weeks ; grapes, eight weeks and four days ; apricots seven weeks; and plums, ten weeks. At the end of the periods mentioned, the fruits were found to have retained their bloom, and to have preserved their flavour. The control apples, kept under ordinary conditions, went bad in a fortnight, and the control pears in about a week. I am inclined to think that the surface of the fruit should be sterilized before being placed in the cold dry air, and some degree of success in this direction was obtained by the use of formalin. Bacteria and other micro-parasites (moulds and aspergilli) are the cause of decomposition, and preliminary treatment of this kind is indicated. Grapes are difficult to preserve, because moulds readily flourish upon them. Moulds grow at low temperatures, and are the chief enemies of the experimenter.

Varnished Fruits.

Fremy showed us that fruits covered with varnish do not ripen, and I have conducted experiments in this direction. A very good varnish is made up of gelatine, gum arabic, glycerine, and very dilute sulphuric acid. The varnish consists of gelatine, 10 parts ; gum arabic, 5 parts ; glycerine 2 parts, and dilute sulphuric acid, (1 in 5,000), 100 parts. Any fruit-grower wishing to demonstrate the

practicability of preserving fruit by this method can do so by adding the gelatine gum arabic (in solution) and glycerine to the dilute acid solution, and heating it until the whole of the gelatine is dissolved. The mixture should not be allowed to set, but should be kept in a water bath at a temperature of about 110°, and the fruit should be dipped into it. After being dipped, the fruit should be allowed to dry on a wire framework, having a vessel beneath to catch the drippings, and, when completely dry, the fruit should be wrapped in paper and kept in a cool place. In my opinion, this method will never possess any commercial advantages for any fruits other than lemons and oranges.

Fruit Pulp.

The industry of pulping fruit for export is one that is sure to assume prodigious proportions, now that successful preservation of the product is absolutely assured. If profitable markets abroad can be secured for fruit in the form of pulp, a powerful impetus will be given to the fruit industry. Up to the present, the export trade in pulp has been mainly confined to raspberries and apricots. The question of the preservation of fruit pulp is a bacteriological one, and the success of the undertaking depends on efficiency of sterilization and on warranty of the hermetic seal of the tins. If pulp can be preserved in such a way that the fruit is not reduced to a homogeneous mass, but retains in great part the shape of the fruit, or the pieces of the fruit, almost just as they were when placed in the tins, then the value of the pulp as a marketable commodity should be enhanced. Experiments were conducted during the year with apricots and peaches that were stoned and packed in halves, in tins capable of holding 10 lbs. net weight of fruit. The fruit was first scalded to remove grit and allow of absorption of moisture, and then packed in tins, the lids of which possessed apertures to allow of the escape of the steam. After steaming for half-an-hour in a calcium chloride steam pan at a temperature ranging from 210° to 240° Fahrenheit the tins were hermetically sealed and then boiled off at a temperature of 240° for half-an-hour longer. Samples of pulp so treated are to be found in Mr. Martin's office, and at the freezing works, Flinders-street. If this system of preservation be properly carried out it is impossible for pulp to undergo any change by any ferment, whether organized or unorganized, so long

as the tins are perfect in construction. In the preparation of the calcium chloride bath, 16 lbs. of calcium chloride are added to the gallon of water. The boiling point of water holding in solution saline matter is higher than that of ordinary fresh water. The boiling point rises as the proportion of saline matter held in suspension increases, until the saturation point is reached, when the temperature remains fixed.

Egg Preservation.

There are varnishes which hermetically close the pores of the shells of eggs and so preserve them from decay; but these meet only part of the requirements, because, when the eggs are being boiled, the substance is not readily dissolved, and the eggs burst from the expansion of the confined gases which can obtain no outlet. If the eggs are pricked before being placed in the hot water, the bursting does not occur. There is then an objection to the isinglass and other hermetic agents which are now in use for preserving eggs. Lime and salt, though free from this objection, give the eggs an undesirable flavour, and so are not to be recommended. Experiments were conducted for the purpose of devising a means whereby an absolutely safe and simple method could be relied upon to pack eggs for export. Eggs were packed in boxes containing sawdust and bran saturated with formalin (1 in 500), and bisulphide of lime (1 in 100). Some of the boxes were kept in a cold chamber at a temperature of 40°, and others kept in an ordinary way at the ordinary temperature of the air. A control box was kept in an ordinary way under the prevailing conditions of the atmosphere at the time. At the expiration of 75 days the eggs were examined, and, with the exception of a little staining of the shell and a little flavour imparted by the saw-dust and bran, the eggs treated with the preservatives were perfectly fresh. The eggs in the control boxes were rotten. It was noticed that the eggs stored in the cold obtained no advantage over the eggs stored under the ordinary conditions of the atmosphere. Further experiments are to be conducted with kapok and other material as packing media, and the faults occasioned when sawdust and bran were used are expected to disappear. The coating of eggs with gelatine (isinglass) varnish is certainly a safe way of preserving eggs, but from a commercial stand-point the method has many disadvantages. For the pastrycook who uses the eggs in a

raw state it is a commendable method, but there is somehow a prejudice against their use for table purposes. The varnish used for coating fruit can be employed in the preservation of eggs.

Animal Diseases.

Many various morbid specimens have been minutely examined, from time to time, to ascertain their nature, and, in certain cases, cultivations of the germs occasioning the diseases were made, and inoculation methods practised to reproduce the diseases in susceptible animals. Cases of tuberculosis, pleuro-pneumonia, anthrax, symptomatic anthrax, roup, sarcoma, carcinoma lymphodenoma, lipoma, actinomycosis, hydatids, coccidiosis, spiroptera, and other conditions due to animal parasites, were encountered.

Spiroptera.

Cases of disease caused by the *spiroptera megastoma*, a small round worm, occasionally occur, These worms cause pretty large fibro-cellular tumours in the stomachs of horses, and they live encapsuled in the swellings. They reach the stomach along with the food, and, when introduced into that organ, set about boring into its walls. They penetrate the mucous coat and settle in the sub-mucous areolar tissue. In the areolar tissue they set up an inflammatory process and eventually surround themselves with fibro-cellular capsules. In the capsules one or more worms may be found. A tumour the size of an orange may be found, and surrounding this large one are several smaller swellings. The worms may continue to reside in the tumours for a very long time, but eventually they commence to bore their way out of the capsules and establish communication between the various chambers and ultimately reach the lumen of the stomach. The adult worms and embryos eventually escape to the outside world with the dejecta. On examining an affected stomach, openings in the mucous membrane leading into the substance of the growth may be readily seen. On cutting across one of these swellings, it is seen to be traversed with canals which were made by the worms during their boring operations, and that these canals communicated with the openings in the mucous membrane. Many capsules containing the worms *in situ* may be observed on section.

Microscopically, the tumours are observed to have a fibro-cellular structure. Fibrous tissue predominates between the capsules. Sections taken through the capsules show very small round cells. A few large oval cells are also seen, and alveoli containing cells may be noticed. Blood vessels are numerous and around the vessels layers of small round cells are disposed. The worms themselves are about the thickness of a fine thread and taper to a point at posterior extremity. The sexes are distinct. The male is about half-an-inch long and the female about three-quarters of an inch. Fertilization of the ova occurs whilst the female is in the canals of the tumours or in the cavity of the stomach. In their life history, spiroptera probably pass through an intermediary host. The female lays its eggs in the alimentary tract of its host and they eventually escape, with the dejecta, to the outside world, where they are eaten by meal-worms, grubs, or caterpillars. An animal that swallows the intermediary host, containing in its body the embryos of the spiroptera, or that swallows the embryos after their escape from the intermediary host, is likely to contract the disease.

The treatment is preventive, and even then not much can be done in the way of prevention. All fodder should be cleaned as far as possible, to prevent risk of infection, of grubs, worms, caterpillars, &c., that find their way into the bins or other food receptacles. In the bodies of these creatures, the eggs of the spiroptera undergo a certain stage of development. Meal-worms, coming with cargoes of meal and grain from across the seas, may contain in their bodies the larvæ of spiroptera. The worms often perish and fall to fragments amongst the meal and grain, and the embryos then are set free, and, on being swallowed, attain maturity. When the worms have perished, setting free the embryos of spiroptera in the fodder, nothing really can be done to prevent infection occurring.

In cattle, these worms occasionally form nodular growths of varying size in all organs and tissues. The lungs, liver, and spleen, may be loaded with nodular growths. The membranes of the brain and even its substance may be invaded. The alimentary tract may be studded, and even all the muscles may display the growths. They may exist also beneath the periosteum of bone and in the sheaths of tendons.

Anthrax.

During the past year, I had occasion to examine into a small outbreak of anthrax in cattle at Alphington. Anthrax is a contagious disease occasioned by specific bacteria. The germ of anthrax is the largest of all pathogenic germs. It is usually straight, non-motile, and possesses square ends. It multiplies with extraordinary rapidity in the blood, clogging the capillary circulation. Anthrax is a disease that runs a rapid course in susceptible animals. All animals except dogs, Algerian sheep, and white rats, are susceptible. It is a disease which occurs rather in autumn and summer than in winter and spring. It is especially a disease of moist tracts of country. The germs are carried about by the air, by food and by water. Anthrax, once introduced, may become endemic in a field. Infection is caused by the ingestion of food and water contaminated with the virus of the disease, or by wounds inflicted upon the buccal mucous membrane by siliceous grasses contaminated with the spores, or the virus may enter through wounds in the feet. Bites of insects may also set up the disorder—the insect being a carrier of the infection. Inhalation in cattle may prove a source of infection (such means of infection occur in the human subject). The belly of an animal dead of anthrax is swollen up from flatus. If the tissues under the skin of the back and sides be pressed upon a crackling is felt. This condition is known as emphysæma, and is brought about by the presence of gas in the tissues beneath the skin. Blood may escape from the various orifices of the body before death, and so the pastures become infected. The spleen, on examination, is found to be greatly enlarged, and the contents have a fluid consistency resembling thick, tarry blood. The blood generally is black and tarry. In guinea-pigs considerable inflammation extends from the point of inoculation, and the subcutaneous tissue is distended with blood serum of a gelatinous consistency. The same condition is noticed in animals dead of malignant œdema, but the germ of malignant œdema is motile and rounded at the ends. The bacillus of malignant œdema is present in soil and dust, and invades animals through wounded surfaces. Malignant œdema is not contracted unless the germ is introduced into the system through wounded surfaces. Wounds inflicted during shearing have proved a source of infection, and all such wounds should be covered over with Stockholm tar immediately after being caused.

When once it is certain that an outbreak of disease is due to anthrax, the body of no animal dead of the disease should be opened. If the body be not opened, the bacilli die. They are aerobic germs, and cannot long maintain their existence without oxygen. If the body be opened oxygen gains access, and then the germs flourish. Moreover, the specific bacilli in the interior of the carcass are also killed off by putrefactive and other organisms that inhabit the soil, and which prey upon the germs of anthrax. The carcass of every animal dead of the disease should be burnt. If this be not practicable, the bodies should be buried at least six feet below the surface of the ground, and enveloped in chloride of lime, and then covered over with ordinary builder's lime before the hole is filled up. At the spot on the paddock, where an animal dies, spores of the disease may remain, and maintain their vitality. The spores may be carried into the ground, and may also be carried by the rains into water-courses. Such spots should have fires burnt over them, and then afterwards be covered over with oxide of lime.

Abscesses in Sheep.

In July, 1898, I reported the result of investigations conducted into a disease in sheep which seemed to be on the increase in certain tracts of country, and I then pointed out its specific character. In the summer of 1898–99 I continued inquiries and investigations upon the subject. This summer (1899–1900) it has not been nearly so prevalent. In the early part of the year (1899), before the Geelong Farmers' Club, I gave an account of the disease, which is of bacterial origin. It is, however, not a highly contagious disorder. The contagium is derived from the ground, and can only invade the animal when its cutaneous investment is injured. The disease evidently has not yet received much attention, as it obtains no prominent place in pathology. It was first described under the name of pseudo-tuberculosis by European pathologists. It has not yet been shown how it came to be introduced into Australia. A few years back it was unknown in Australia.

The disease is characterized by swellings, which vary in size from that of a plum to that of an orange, and which occur as a rule in the lymphatic glandular system. It is a rare thing for any other organ to be attacked. On section at an early stage the swellings disclose a more or less tough

fibrous capsule enclosing a greater or less amount of thick viscous material. At a later stage, the contents are firmer and more friable. Sometimes, indeed, the contents are quite firm and solid and arranged in layers. There may also be detected, in the pus of some of the tumours, calcareous particles, or calcification of the whole mass may have occurred, this condition being revealed by the hard stony nodule that is discovered. Again, when superficial, the swellings may burst and discharge their contents, leaving scars to mark their previous situation, or there may be left cavities lined with cheesy material. In some few cases, empyæma is an associated condition—pockets of pus existing between the layers of the pleuræ—and occasionally the kidneys are found involved. The contents of the abscesses usually possess a distinct green colour, or there may be various shades of green. Sometimes the contents have a greenish-yellow or yellowish appearance. The germ that causes this disease develops in the nutrient media in which it grows not a green colouration, but a white colour in agar, and a light yellow in blood serum. It does not grow on gelatine.

No class of sheep is exempt from the disease, which prevails mostly on stations that are of a marshy character, or that are subjected to occasional floodings. Places where foot-rot prevails are also places where multiple abscesses obtain a foothold.

By culture and inoculation methods, it can be shown that the disease is caused by a particular germ which is short, oval, and non-motile. It varies in length from about $\frac{1}{16,000}$ to about $\frac{1}{10,000}$ of a inch. This germ causes the green-coloured pus observed in the abscesses. Sometimes streptococci and staphylococci are also found. Guinea-pigs and rabbits are susceptible to the disease by inoculation methods, but dogs are not. Guinea-pigs and rabbits develop abscesses in the lymphatic glandular system, liver, spleen, kidneys, and lungs. If large doses are inoculated, guinea-pigs and rabbits are quickly killed, and extensive œdema spreading from seat of inoculation is observed. Small doses kill in from 25 to 35 days. Inoculated animals become very thin and die of exhaustion. Sheep inoculated, either in feet or groin, or axilla, become lame. An abscess soon forms in the nearest lymphatic glands, and the animals are very sick for about ten days after. They refuse to eat, and lie about, seeking a shady place in which to recline. They may become very weak.

There may be a considerable amount of suppuration around the point of inoculation. The temperature may rise to 107° (normal 104°). Pus that had been kept two months in the freezing chambers caused the death of two animals. Cultures from pus derived from guinea-pigs, or from sheep suffering from the disease, or pus from abscesses of freshly killed sheep or guinea-pigs, did not produce fatal results in four other cases. The four sheep experimented upon were killed eight to ten weeks after inoculation, and were, all things being considered, in fair condition. Single abscesses had formed in glands nearest the seat of inoculation. The primary sores, it was observed, healed up in about three weeks. Any wound or abrasion in the neighbourhood of the feet of sheep leaves an opening through which the germs can invade the system. The germs from the soil enter the wound and traverse the lymphatic vessels until they gain the nearest lympathic glands, where they may be effectually arrested in their progress. There they grow rapidly, and excite a small round cell-growth, which soon becomes caseous in the centre of the nodule. Resolution does not appear to be a prominent feature, and so caseation, suppuration, and calcification occur. The abscesses, in some cases, may burst externally, discharging their contents. There is seen frequently enough extending along the penis, in wether sheep, small collections of pus surrounded by thick fibrous bands. As a rule, the disease is arrested at the first chain of glands, above the seat of entrance of the morbid material. In some cases, however, the irritant passes beyond this barrier to the next chain of glands, and from this chain to the next, and so on, until many chains of glands are involved. It would appear to be the rule for the whole structure of affected glands to be destroyed. The primary cause of the invasion of the lymphatic system by the micro-organisms that produce the disease is to be sought in a stab, prick, abrasion, burn, grass-seed wound, or from some injury to the feet caused by roughness of ground. A slight wound is sufficient to admit of the entrance of the virus. The primary sore heals and leaves, as a rule, no trace of its previous existence. The superficial inguinal and prescapular glands are found most frequently affected, the virus having entered by wounds in the feet. It is, however, more common to find the superficial inguinal glands diseased than to find the prescapular glands diseased. The deep glands of the inguinal region are not often involved, but occasionally they are. In the severer

forms of the disease, the mesenteric and sublumbar glands, and even, perhaps, the post-pharyngeal and sternal glands may be involved. Breaches in the continuity of the skin allow of the entrance of the virus. Sheep roaming over hard ground abrade the feet and so permit of the introduction of the micro-parasites. Wounds inflicted during shearing, castration, and paring the feet are also channels of invasion. Burns, such as are received by bush fires, and wounds created by grass-seeds are further sources of the introduction of the germs. Grass-seeds, frequently enough, enter the sheath of the penis (pizzle), and may set up considerable inflammatory trouble, giving rise to the condition know as "big pizzle."

The disease may exist and yet sheep may betray no symptoms of its existence. It occasions no mortality. Neither dogs, nor guinea-pigs, nor rabbits, nor fowls are harmed by feeding them on material derived from the abscesses. It does not seem to disturb the health of sheep after the initial fever has subsided. Prime sheep are, often enough, found affected.

To prevent multiple abscesses, all wounds and sores, particularly those about the feet, should receive early attention. Foot-rot is a condition that demands early treatment. The feet should be well pared, and the sheep frequently driven through copper and arsenical foot-baths. Sheep on stations where abscesses prevail, should once a quarter, at least, be driven through foot-baths. All wounds made by incision, either during shearing or castration, should, when practicable, be smeared with salt, and afterwards covered over with Stockholm tar. Whatever prevents foot-rot would assist also in the prevention of abscesses. The removal of sheep from marshy lands, and the drainage of marshy tracts of country, would arrest the spread of the disease.

The injection of tuberculin into sheep suffering from the disease produces no disturbance of the body temperature. Mr. John Cooke, of Newport Freezing Works, kindly supplied all the sheep for the experiments, and Mr. Benn, the manager of the works, together with his assistants, helped me greatly in the work.

Tuberculosis.

Several specimens, derived from tuberculous sources, were from time to time examined, and inoculation methods practised, particularly with milk supposed to have come from animals with diseased udders.

Tuberculosis is a disease that prevails naturally amongst mankind, cattle, and swine. Apes and monkeys kept in confinement contract it. It occurs, to a slight extent, in domesticated birds, and in wild birds held in confinement. Speaking generally, the rest of the animal kingdom is not susceptible to the disease under natural conditions. It is, however, a disease widely distributed over the globe. It sweeps off one out of every seven of the human race. The other six of the seven are no doubt resistant to tubercle. If this were not so, the disease would sweep off the human race.

Of Victorian cattle 7 per cent. perhaps are tuberculous. In swine about ·5 ($\frac{1}{2}$) per cent. are found tuberculous.

In man and the lower animals, the disease is seldom hereditary. If young animals, born of tuberculous mothers, were promptly removed from the influence of the mother's surroundings, it would be found that they could be reared free from tubercle. The danger, perhaps, does not lie in the mother's milk infecting the bowels of the young creatures, but there is every danger of the progeny contracting the disease by the constant inhalation of air poisoned by the exhalations and discharges of the mother. There may be even danger perhaps from the young swallowing with their food germs scattered abroad by the diseased parents that have reached their mouths and throats by means of inhaled dust. Again, matter coughed up from the lungs of the mothers may contaminate the food of the young, and thus another source of infection is opened up. Speaking generally, calves are born free of the disease, and when calves do contract it after their birth they contract it in one or other of the ways pointed out. Tuberculosis is a rare disease in calves, but it does occur in them, and every precaution should be taken against their catching the disease. In every case, mature cattle contract the disease from their surroundings. In cattle, inhalation would seem to play a greater part in the production of the disease than alimentation.

In oxen and swine, the disease, if the animals at an early stage of it are properly fed and properly sheltered, tends to undergo spontaneous cure, and, in the human subject, we look for a cure to become established under a certain regimen. Life in the open air and sunshine are antagonistic to the development of tubercle, and the open-air treatment of the disease in the human subject is indicated by the effort nature makes to bring about a cure in cattle and swine.

Damp mountain valleys and heavily timbered places, where the sun's rays are obscured, are localities favorable to the development of the disease in cattle. Sunlight exerts a powerful disinfectant action on the tubercle bacillus, therefore plains not too well wooded are localities where it should not naturally abound to any great extent. Our dairy cattle are not housed up for months together as is the case in some other parts of the world. They are always allowed to roam at large, and this constant life in the open is conducive to health. Where animals are housed together for months of the year tuberculosis is rife.

In order to prevent tuberculosis from occurring, and it ought to be a preventable disease in cattle, animals should be kept, when conditions are favorable, as is the custom, in the open, and in winter should be protected from cold and wet by rugs.* The expense incurred in rugging would soon be returned from the increased milk supply. Where practicable, they should be housed on cold wet winter nights. Shelter sheds should be erected in the paddocks where cattle graze so that by day they may also be given the advantage of protection from the inclemency of the seasons. Animals, moreover, should be properly fed. A well-fed animal is better able to withstand the effects of cold and wet. Animals properly kept and properly fed are not prone to tuberculosis, but ill-kept and ill-fed animals are. Wherever there is lowered vitality, there the tubercle bacillus tends to find lodgment. Tuberculosis is caused by the entrance into the body of bacilli derived from tuberculous sources, and animals suspected of having tuberculosis should be kept apart from healthy ones. It may, perhaps, be somewhat cheering to learn that the matter coughed up by sick beasts, on being exposed to the action of direct sunlight, will be disinfected by the sun's rays before it has undergone complete desiccation. Now, it is only when it has become desiccated that it is in a condition to be carried about by the air as dust. Then, again, sunlight, if in every instance it does not a actually kill the germs, so attenuates their virulence that it greatly deprives them of the power of gaining a foothold in the system of animals. There are certain causes that predispose to tuberculosis, and these are:—

Insufficient and unwholesome food.
Breeding too young or too frequently.

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* This is the almost universal practice in the Netherlands.

Inbreeding.
Exposure to cold and wet.
Being kept in unhealthy surroundings, as is the case with cattle in cities and towns.

Moist changeable climates favour the disease, while in districts with dry and rare air and uniform temperature, there is a tendency to its suppression.

The symptoms of tuberculous disease in cattle are so obscure and variable, except in advanced cases, that it is difficult to express an opinion on a malady unless tuberculin is resorted to. Tuberculin is a preparation for the detection of the disease, and is the only agent at present in existence for determining with any degree of reliability the existence of tuberculous disease in cattle. It is a glycerine extract of the tubercle bacillus. In animals diseased with tuberculosis, it, in about 97 per cent. of cases, occasions, within a few hours after the injection of the drug, a notable rise of temperature, no such reaction, except in rare cases, being observed in healthy beasts. Yet, although it gives an indication of the presence of disease, it gives absolutely no knowledge of its extent, and the question arises as to the wisdom, then, of killing an apparently healthy beast on the strength of the reaction obtained. Again it may be asked, what is the use of tuberculining animals unless it is intended to follow up the tuberculin indications? An animal with a small tuberculous lesion may give a pronounced rise of temperature, whilst an animal badly diseased may not give an indication sufficiently clear to establish a sound diagnosis. If, however, clinical examination establishes the presence of the disease, such an animal should not be tested with tuberculin, as a vitiated result would be sure to be obtained.

The use of tuberculin is not altogether free from objections. There is a danger of setting up generalized tuberculosis when it exists in a localized form, and its inoculation into a healthy beast may render it susceptible to the disease. Tuberculin is a physiological poison, and it actually is the agent which produces the effects of the disease in tuberculosis. It cannot, if properly prepared, actually produce the disease in a healthy system. It is, as a rule, quickly and steadily eliminated from the system by natural processes, but, while it is present in the body, the bacilli—if there be disease—propagate rapidly. In some cases, it may not be readily eliminated, and may thus favour infection occurring. The system of a tuberculous animal is more or less impregnated with tuberculin. The

animal becomes accustomed to the presence of a certain amount of the poison, just as the system of a human being tolerates certain amounts of alcohol, nicotine, morphia, cocaine, and other poisons. Certain quantities of these poisons can circulate in the blood of a man used to them without producing toxic results. An overdose, however, disturbs the balance. If a dose of tuberculin over and above that to which the animal has been accustomed be injected into its system, the bacilli present in the body are excited to unusual activity, and the characteristic change in temperature is the result. As the temperature of oxen is upset by trifling causes, tuberculin should not be inoculated into any animal unless it be completely rested, quiet, and cool. The animal should receive both food and water preparatory to and during the test. Before the injection of the drug, the temperature should be taken some two or three times, say at intervals of two hours. No reading should be taken unless the animal be quite cool. In summer, animals should be kept in a cool place. Exposure to the sun's rays raises the body temperature; so, unless the animals are kept quite cool, and free from exertion and excitement during the progress of the test, errors might easily creep in. The temperature should not be taken immediately after exertion, but only when the animal has rested, as exertion raises the body temperature. A large draught of cold water may cause a fall in the body temperature, so a reading is not taken immediately after the ingestion of a large quantity of water, but an hour or so later. Slight disturbances of digestive processes may also cause a deviation from normal temperature. The tuberculin is usually injected beneath the skin, at a point behind the shoulder. The dose is 5-6 minims. The injection of tuberculin, as a diagnostic, neither affects the quantity nor the constitution of milk in milch cows.

It may, perhaps, be of interest to briefly narrate the results of experiments conducted by me with tuberculin. At the first place at which experiments were conducted, 30 animals were tested, and, of these, four gave a notable rise of temperature. The differences between the highest natural and highest reaction temperatures, ranged from $1\frac{2}{5}$ to 3 degrees, and there was a persistency in the rise, the temperature keeping up for over 30 hours. The reacting animals showed no obvious signs of disease, and I decided to re-test them. Five days later, the four animals were again tested, and the

differences between the highest natural and highest reaction temperatures ranged from 0 to $\frac{2}{5}$ of a degree. None of the animals were condemned.

At the second place, 39 animals were tested, and of these twelve gave a notable rise of temperature. Of the twelve, five indicated a rise above highest natural, ranging from $2\frac{1}{5}$ to $4\frac{2}{5}$ degrees, and were condemned. Nearly two months later, the remaining seven were re-tested, and three gave a rise ranging from $1\frac{3}{5}$ to $2\frac{2}{5}$ degrees, and were also condemned. The other four gave a rise above highest natural of from $\frac{2}{5}$ to 1 degree, and as they were healthy-looking beasts they were not interfered with. On slaughter, all the condemned animals showed tuberculous lesions. Five had lesions in the lungs and mesenteric lymphatic glands; one had lesions in the lungs, mesenteric, and post-pharyngeal lymphatic glands; one had lesions in lungs, mesenteric lymphatic glands, and udder; one had lesions in lungs only. Another animal in this herd was condemned for actinomycosis of jaw. It gave no rise of temperature on the injection of tuberculin.

At the third place, twelve animals were tested, and, of these, one gave a rise of temperature of $4\frac{1}{5}$ degrees above highest natural. It was condemned, but no tuberculous lesions were found in any organ. There was a condition of lobular pneumonia in this case, and hydatid cysts were also noticed in the liver and lungs. Another animal that gave no rise of temperature, but which presented suspicious symptoms of disease, was also condemned, and it was found to have hydatids of liver and fluke. There were also some small ulcers on the teats. At the fourth place, twenty animals were tested, and, of these, one gave a rise of 3 degrees above highest natural, and was condemned. No tuberculous lesions were found, but the lungs and liver were loaded with hydatids. Another animal which gave no notable rise of temperature, and which had a tumour at the angle of its right jaw, was condemned, and examination revealed that the swelling was an enlarged lymphatic gland of chronic inflammatory origin. There were also hydatids of liver and lungs.

In odd cases, where I have tuberculined animals suspiciously tuberculous, the results were tolerably accurate. In one of these cases, tuberculosis of the udder existed. In another case, however, where a rise of three degrees above the highest natural temperature was obtained, it was shown,

post-mortem, that the animal was non-tuberculous. An enlarged submaxillary gland—the result of chronic inflammatory processes—was the only morbid condition that could be discovered.

Actinomycosis.

Actinomycosis, a disease of which so much has been spoken lately, is a condition characterized by the growth of tumours of varying size and shape. It generally begins about the jaws and sockets of the teeth, but it may arise in other situations. It may even arise as a primary affection of the lungs or of the glands about the jaws and throat. The disease owes its origin to a vegetable parasite—the Ray Fungus, or Actinomyces—and it occurs, in man, cattle, and swine. In swine, it occurs about the jaws, lymphatic glandular system, intestines, and mammary glands. On cutting into one of the tumours, it is seen to possess a spongy open appearance, and a nasty-smelling discharge can usually be expressed, and, in this discharge, are seen little round yellowish granules, which consist of clumps of the fungus. The fungus enters the body through wounded surfaces and carious teeth, and may even enter by inhalation of air. The fungus, or its spores, exist naturally on the ears of cereals and other fodder plants, but it is chiefly by wounds caused by silicious grass-seeds that the disease is set up in the neighbourhood of the mouth. In this disease, the tendency is for the tumour to naturally burst, either externally, or internally into some cavity of the body. The discharge is at length scattered over the pastures or upon material used as fodder. Animals pick up the spores from the pastures, or from contaminated fodder supplied to them by hand.

No drug given internally can possibly arrest the growth of this parasite. If the tumours are accessible, and they nearly always are, free incisions should be made into them, and then they should be scraped out with a sharp spoon. The cavity should then be plugged with wool soaked in tincture of iodine, or 5 per cent. carbolic acid. In any given tumour, it is more than likely that the actinomyces have invaded the wall, and drastic measures must be resorted to to make certain that all the dangerous tissue is destroyed. Whenever the tumour can be completely excised this should be done.

Pleuro-Pneumonia.

Epizootic pleuro-pneumonia is a specific constitutional disease occasioned by very minute micro-organisms. It is

a disease confined to cattle. The contagium spreads through the medium of the air. There is an exudation of fluid into the tissues of the lungs, and into the cavity of the pleuræ. The germs take a certain time to develop in the body before any manifestation of symptoms occurs. The time they thus occupy is called the period of incubation of the disease, and usually occupies from 37 to 42 days. Shorter and longer periods have, however, been recorded. Animals in a herd are not attacked simultaneously, but in succession.

On examining the chest of a beast dead of the disease, when the disease is at all advanced, the cavity is found full of clear straw-coloured fluid. Adhesions of the lungs to the chest walls may be encountered. The lung substance is hard and inelastic. This is due to the air spaces and smaller bronchial tubes being blocked up with inflammatory products. The cut surface has a marbled appearance, bands of thickened interlobular tissue engorged with fibrin extending between the lobules. The marbled appearance results from the existence in the lung of dark red or purple areas, separated by thick bands of fibrin. This tissue may break down and a purulent mass result, with the formation of abscesses of the lung.

In order to stay an outbreak, inoculation methods must be practised. The lymph taken from the chest cavity of a beast that has died of the disease, and free from any other malady, should be employed for the purpose.

Symptomatic Anthrax.

Symptomatic anthrax, or black-quarter, is a disease of damp districts and occurs mostly in spring and autumn. The germ that causes it is motile, rounded at the ends, with a shining spore at one end. Young cattle are mostly affected. Sheep are experimentally readily infected, with fatal results. Under natural conditions, however, they do not contract the disease. Guinea-pigs and rabbits are susceptible, but dogs and fowls are not. The disease does not affect human beings. The virus lives for long periods outside the bodies of animals, in the soil and water, and, unlike the bacillus of anthrax, thrives where putrefaction is going on, and when deprived of oxygen. In about 48 hours after the invasion of the virus in a susceptible animal, distinctive symptoms appear. The disease is contracted by the germs entering through some wound of the skin, such as

occasionally exists about the legs and feet of young cattle. Young cattle are more often affected than adults, and it is practically a disease of young animals from six months to two years old. Some affected animals recover, so the disease is not absolutely fatal. The virus affects the connective tissues and muscles. A very minute quantity inserted into these structures is soon followed by their disintegration. The muscle fibres are broken up, blood escapes from the vessels, gas is produced (emphysæma), and a more or less extensive swelling, to which the gas gives a peculiar crackling sensation on manipulation (crepitation), while the escape of blood and the alteration in its constitution, gives that dark colour to the tissues from which the disease derives its name, black-quarter. The affected parts are intensely virulent, and a small quantity inoculated into a guinea-pig proves fatal. The carcass of an animal, dead of the disease, long maintains its infectivity, and on this point depends the fact that fields, where animals have died and have been buried, long remain places where the disease is likely to recur. The germ, perhaps, can maintain its existence in the soil for an indefinite period. Diseased animals should at once be isolated from the healthy. Vaccination should prove effective against this malady. All carcasses should be burnt or buried intact in chloride of lime deep down in the ground. Drainage of affected areas is requisite to stamp out the disease. Cultivation of infected areas lessens risk of contagion.

Poultry Diseases.

Poultry breeders have a great many parasitic pests to contend with, and some are very destructive to bird life, a circumstance which has led to special investigations being made into their habits. Among the insect pests, the fowl-tick (Argas Americanus) is a scourge in poultry-yards, the poultry mite (Dermanyssus Avium) is a source of great trouble, the Acarus Depilis or Cytodites Nudus, a very small mite, infests nearly all yards, but does not seem to produce any mortality, and the Sarcoptes Mutans, which causes scaly leg, is not an uncommon parasite. The hen flea (Pulex Avium) and the various species of lice (Goniodes Dissimilis, Goniocotes Hologaster, Lipeurus Variabilis) deserve only a passing notice, inasmuch as they can be kept well under control by the exercise of ordinary cleanliness. The floors, ceilings, nests, and perches of fowl-houses should

be frequently lime-washed, the nests should be frequently renewed, and dust-baths containing a little pyrethrum powder should be distributed about the runs.

Round-worms and tape-worms infest fowls, and the round-worm (Sclerostoma Syngamus) which inhabits the trachea, is particularly destructive. The round-worms and tape-worms that have their home in the intestinal tract do not seem to much disturb the health of birds, and are capable of being expelled by the use of proper anthelmintics.

Fowl Tick (Argas Americanus).

A pamphlet dealing in a general way with the anatomical characters, life history, and habits of this formidable pest has been published by the Department. The female tick is larger than the male. The female is usually about $\frac{1}{4}$ or $\frac{3}{8}$ of an inch long. After the ingestion of blood, the colour of the body is reddish-brown. The body is oval in shape, and the dorsal portion anteriorly projects over the head and mouth, and posteriorly it projects over the anal and reproductive openings. The whole appearance presents a tortoise shape. The whole of the upper surface of the body, as well as the margins of the under surface, is covered with stigmata or breathing pores—the external openings of the air tubes. There are four pairs of legs, each consisting of five segments, and the distal segments possess long curved claws. The female lays her eggs in crevices of wood-work, or under the bark of trees. The young are soon hatched, and after repeated moultings attain the adult form. The ticks are nocturnal in habit. They hide by day in the crevices of fowl-houses, &c., and may, perhaps, even be found under the wings of fowls. At night they sally forth to commit their depredations. They cause anæmia and death from exhaustion. They are very tenacious of life, and to kill them it is necessary to block up their breathing pores.

When fowl tick appears on a place, there is no other course open, if the owner wishes to rid himself of the pest, but to pull down wooden fowl-houses and erect corrugated iron ones capable of being readily dismantled. The houses should, from time to time, be dismantled and washed with solutions of lime and sulphur. All places that harbor tick should, where practicable, be burnt, but where this is impracticable all crevices should be cemented up and coated with tar. Tick hide sometimes under the bark of trees, and such trees should

be uprooted and burnt. All crates arriving from places where fowl-tick abound should be destroyed, as, by means of crates, the disease may get spread widely around.

Hen-Mite (Dermamyssus Avium).

This very small creature may probably be the cause of many of the mysterious diseases in poultry, and, unless it is very carefully sought for, it altogether escapes observation. The female mite, in the fasting condition, is about 1-35th of an inch long, and the male about 1-40th of an inch. The posterior end of the body is broader than the anterior. The mouth parts are sharp, and intended for piercing and sucking. The body and legs are covered with bristles.

The colour of the mite varies from a yellow to dark red. When fasting it has a yellow colour, and, when gorged with blood, it has a dark-red colour. When gorged with blood the mite swells up, and may then be 1-6th of an inch in length. I have kept these parasites nine months without food, and at the end of that time they were quite lively. The ova hatch rapidly into little white six-legged larvæ. After repeated moultings, they arrive at the adult form, and possess then eight legs. They are nocturnal in habit, hiding by day in the crevices of the fowl-houses, and at night they sally forth to seek the bodies of fowls and suck their blood. Fowls subjected to the attacks of these mites do not thrive. They become thin and may die of exhaustion. An examination of the birds at night may reveal the presence of the mites. As they cannot bear the light of day and a free circulation of air, fowl-houses should not be dark, damp, or badly ventilated. In well-lighted, well-ventilated, and properly constructed fowl-houses, they cannot long maintain their existence. Frequent lime-washings are a safeguard against their gaining a foothold. If they do gain possession of old wooden buildings, they should be burnt down and iron ones erected.

Acariasis.

Acariasis is a parasitic disease of enormous extent in fowls, and birds of all ages are attacked. The disease is caused by an acarus or mite (acarus depilis) which invades the tissues of fowls. The disease appears to affect only domestic fowls. I have not seen it in turkeys, geese, ducks (wild or tame), pigeons, widgeons, or teal. The disease is characterized by

the presence of large numbers of little whitish or yellow-whitish round or oval bodies of various sizes in the subcutaneous areolar tissue, or on the serous membranes. Their size and shape vary. The smallest are just visible, whilst the largest are about a line in length. Some again are hard and not easily broken, whilst others are soft, and can readily be torn with needles. The hard variety has undergone calcification. The soft variety has a strong capsule, or egg case, and in it is a thick milky-white fluid. In this fluid are a number of large round or oval nucleated cells, with clear or granular contents. The round cells are oval. As acari in the process of development shed their cuticle two or three times, some of the white bodies may consist of cast off cuticle rolled up into globular masses.

The acarus is a small yellowish-white or whitish looking object visible to the naked eye. The sexes are distinct, the females exceeding the males in number. The creatures are about 1-40th or 1-50th of an inch in length, and destitute of hairs and spines. The upper surface is convex, and the lower surface is flat, and possesses a chitinous frame-work of a brownish colour, for the support of the legs and lower maxillæ. There are four pairs of legs, and each leg has four joints. The distal segment of each leg has attached to it a movable hollow staff supplied with a sucker. At the junction of segment and staff is a bent claw. The maxillæ are short and rounded anteriorly and surround the mouth.

The acari bore their way through the skin, or may perhaps descend through the channels of diseased feather follicles to reach the subcutaneous areolar tissue of fowls. On getting into these tissues they wander through them, the females depositing their capsules of eggs as they go along. The eggs are hatched in the tissues, and the young acari then wander through the loose tissue to gain the peritoneal cavity. When they gain the region of the neck, they follow the course of the trachea, œsophagus, and stomach, until they reach the body cavity. In the body cavity they may be found on the peritoneal surfaces. Their further history is ill-defined. They may bore their way through the walls of the intestines to reach the lumen of these organs, and thus escape to the outside world with the fæces. The acari leave no trace of their passage through the skin, and it is only on some of the affected fowls that diseased feathers are found. On turning aside the feathers, and examining carefully the skin, the

little bodies may be seen through it. The treatment is preventive. Many poultry owners make no proper provision for housing their birds. The fowls are kept in old dilapidated buildings, and the old timber of which they they are constructed harbors all kinds of vermin. Nothing short of the destruction of these old buildings will save the fowls from becoming infested. Fowl-houses should be constructed on proper plans, and the walls, and roosts, and nest boxes should be frequently limed or tarred. The floor should be of asphalt, or even of ashes and lime. The houses should be properly ventilated, so as to permit of a free circulation of air. If an examination of the skin reveals the presence of the small bodies already described beneath it, then the administration of sulphur may be tried, with the object of killing the acari in the tissues. The sulphur can be given in the form of a bolus made up with flour or bran.

Scaly Legs.

Scaly leg is caused by a mite, the sarcoptes mutans, which is about 1-50th or 1-60th of an inch in length. This mite, when it gets on the legs, sets up considerable inflammation. The scales of the legs and feet are raised up and separated from one another by the inflammatory products. The inflammatory products in time dry up and form crusts or scales, the whole morbid growth having a spongy texture. The parasites are found in this material and beneath it. The females are oviparous, and the larvæ soon reach the adult stage. As the disease progresses, the birds become lame and eventually lose the power of their legs, and the general health is much disturbed. The disease is spread through contact of diseased with healthy birds. The treatment consists in washing the affected parts with a solution of 5 per cent. caustic potash, to remove as much of the scaly material as possible, and then rubbing in ointment of sulphur. ---

Roup.

Roup is a specific infectious disease in fowls and is characterized by a catarrhal inflammation of the mucous membrane of the nasal tract. It occurs periodically at all seasons, but obtains a maximum severity in autumn and winter, when it is epidemic.

The incubation period is evidently a short one. The actual cause of the disease is a small micrococcus found abundantly

in the secretions of the mouth and nose. Exposure to cold and wet, draughty and ill-ventilated fowl-houses, want of cleanliness and improper feeding are predisposing causes. When there is lowered vitality, the specific micro-organism finds a suitable nidus for development, thus leading to the production of the symptoms that characterize the disease.

Symptoms.—The first thing that perhaps attracts attention is the appearance of a thin serous discharge from the nostrils, and as the disease progresses and the symptoms become more pronounced, it assumes a muco-purulent character. It is then slimy, tenacious, with fœtid odour. In some cases a swelling of the eyelids and head is noticed and a watery discharge issues from the eyes. The lids may swell so as to close the eyes. The tongue may be furred, but no membrane forms thereon. There may often be seen adhering to the tongue some tough mucus which, on removal, displays the organ furred or a little reddened. Weakness comes on early, and gradually increases. The colour of the wattle, and also of the face and comb, changes, the wattle loses its redness and becomes pale. Elevation of temperature above normal (107°) occurs. As the disease progresses the discharge blocks up the nasal tract, and the bird is compelled to respire with the mouth open. The bird may be seen, in the usual run of cases, either standing or sitting with its head under its wing, or retracted on its shoulders. When it places its head under its wing, the discharge flowing from the mouth and nostrils collects there and gives rise to a foul-smelling mass. Thirst is marked, and the appetite is much lessened. Diarrhœa may be present. Death, when it occurs, results from exhaustion. The disease runs its course in mild or moderate cases in about eight or ten days, but in severe cases the duration of the case is prolonged.

When roup appears, preventive measures must at once be adopted to prevent the spread of the disease. Prevent healthy birds from mingling with sick ones. Isolate the sick birds and enclose them in coops standing over a limed surface. The water given the birds to drink should be wholesome, and in the drinking pans of all the birds there should be placed two tablespoonsful of salicylate of soda to every gallon of water. The addition of salicylate of soda prevents the spread of the contagion through the water supply. The nasal tracts of the birds should be syringed out with a 2 per

cent. solution of chlorinated lime, and the mouth should be swabbed out with a camel's hair brush dipped into the solution. The discharge that has been allowed to collect under the wings should be sponged away with a 5 per cent. carbolic acid solution.

Gapes in Fowls.

Gapes is occasioned by a small red round worm—the sclerostoma syngamus—which inhabits the trachea of fowls. The worms may have a fork-shaped appearance. The fork-shaped appearance is due to the copulation of the male and female. The smaller prong of the fork is the male worm. Single straight individuals may often be met with. The male is $\frac{1}{12}$ to $\frac{1}{4}$ of an inch long, and the female $\frac{2}{5}$ to $\frac{4}{5}$ of an inch. The female lays its eggs whilst an inhabitant of the trachea. The ova pass out from the mouth and then undergo a certain stage of development in water or damp situations. The embryos may bury themselves in vegetable matters, or in the moist soils about pools, &c. In some cases they may find their way into the bodies of insects or worms, and there undergo a certain stage of development, but an intermediary host is not required to perpetuate the existence of this worm. Fowls roaming over damp places pick up the embryos along with their food and water, or pick up insects and worms containing them in their bodies, and then ultimately the immature worms find their way into the trachea. The worms cause great distress to fowls. The fowls keep their mouths wide open and make straining efforts to expel the intruders. A frothy discharge may issue from the mouth, and a wheezing sound may be heard. The birds have a dull appearance and their appetite diminishes. As soon as possible the worms should be removed from the trachea. Catch hold of the tongue of the bird and draw it well out of the mouth. The opening of the trachea or windpipe by this means is brought well forward to the tip of the beak; then introduce into the trachea a feather stripped of its barbules to within about an inch of its distal end. The feather, before its introduction, should be dipped in oil of turpentine; twirl it round once or twice in the windpipe and then withdraw it. On withdrawing the feather, the worms will be seen adhering to it. The water given to fowls to drink, when an epidemic of gapes prevails, should be drawn from taps and renewed daily. If tap-water cannot be given, then water drawn from ponds or wells should contain salicylate of soda in the

proportion of three teaspoonsful to a quart. All affected birds should be isolated and kept in as small an enclosure as possible, preferably one with a brick floor. The floor should be washed twice daily with a 1 in 1,000 perchloride of mercury solution, as this destroys the coughed-up worms and embryos. Poultry should be kept off marshy places, as it is in marshy places that they are likely to pick up the embryos.

Hydatids in Rabbits.

Hydatids in rabbits are extremely common. Hydatids are cystic stages in the development of the tape-worm. The hydatid of the rabbit becomes the tænia serrata, a tape-worm infesting the dog. This tape-worm is composed of a great many segments, and each segment may contain myriads of ova, and each œvum is capable of developing into a hydatid cyst. On escaping from the dog the wall of the segment (proglottis) in time disintegrates, scattering the ova far and wide around. In damp situations the ova long maintain their vitality. If an animal swallows, as often happens in the case of the rabbit, a whole segment of a tape-worm, a large number of hydatid cysts may be developed in its body. An hydatid cyst becomes distended with a clear non-albuminous fluid, which may vary much in quantity. In the rabbit the cysts scarcely ever exceed the size of an orange. All the hydatid cysts that are encountered in the bodies of animals are not fertile. The common globular form is usually sterile. The fertile hydatid may contain one cyst within another, and the scolices or heads developed from the inner layers of the walls of the cysts may float about in the liquid contents. This is what is usually observed in hydatids of the rabbit. It not unfrequently happens that hydatids undergo retrogressive changes, becoming converted into granular or fatty or calcareous masses. A dog eating a rabbit suffering from hydatids, is almost sure to contract tape-worms. The scolices or heads, on being set free in his intestines, may manage to get a hold on the mucous membrane and there develop to adult tape-worms. It often enough happens that hydatids are found in every part of the body of a rabbit. They may exist in the muscles, in the skin, in bone, and in every organ. A tape-worm cannot directly give rise to another tape-worm. The cystic or hydatid stage must be passed in the body of some other animal, and from that animal be conveyed to the intestines of a specific host, before it can again attain the tape-worm form.

Hydatids in other Animals.

The hydatid of the ox becomes the tænia mediocanellata, a common tape-worm in man; the hydatid of the pig becomes the tænia solium, a formidable worm in man; hydatids in sheep give rise to tape-worms in the dog.

Coccidiosis.

Coccidiosis is a common disease in rabbits. It is a disease caused by egg-shaped bodies 1-800th to 1-700th of an inch long, called the coccidia oviforma. Each coccidium oviforme has a thick smooth shell, which has a micropylar opening at one end. The contents of the shell are granular, and sometimes uniformly distributed through the whole interior space, or sometimes collected into a spherical mass. In the granular contents a nucleus with nucleoli is observed. These egg-shaped bodies pass from the liver, which they inhabit, to the external world, there to undergo a further development in moist situations. In the liver of the rabbit they form white nodules of various sizes, with thick connective tissue walls. In some cases the whole liver is penetrated with these growths, and in other cases there may be only a few nodules present. Some of the nodules may be the size of a pea, and, from the size of a pin's head to that of a pea, all gradations in size may be found. On cutting across a nodule, a cheesy mass exudes, and the microscope reveals in it the coccidia. It would appear that coccidia do not remain permanently in their hosts. They pass through the communications which persist here and there between the nodules and the bile ducts, and reach, sooner or later, the gall-bladder and intestines, and are finally expelled with the dejecta. Having reached the outside world, they undergo spore formation, and the spores find their way back into the liver of rabbits by means of the ingesta.

Coccidia do not seem to cause any great mortality in rabbits in Victoria. As a matter of fact, I am inclined to the belief that they do not harm the animals, as I have seen rabbits in splendid condition that had been badly affected.

"Fishiness" in Butter, etc.

Into the causes of the condition known as "fishiness" in butter some little investigation has been attempted. "Fishiness" is a wide term, and practically embraces every abnormal taste observed in butter. Germs produce, as the result

of their vital processes, complicated bodies known as ptomaines, and it is to particular ptomaines that "fishiness" has to be attributed. These ptomaines belong to the trimethylamine series of compounds. Before the annual conference of the Australasian Butter Factories Managers' Association in May last year, I showed cultures of micro-organisms that produce disease in milk, cream, and butter.

"Blue milk" is caused by the bacillus cyanogenus, and other germs; "red milk" is caused by the bacillus lactis erythrogenes, bacillus prodigiosus, sarcina rosea, saccharomyces ruber; "yellow milk" is caused by the bacillus synxanthus; "bitter milk" is caused by the bacillus of bleisch and yeasts, and by the cows eating certain herbs; "ropy milk" is caused by the bacillus pituitosi, bacillus lactis viscosus, and others; "soapy milk" is caused by the bacillus lactis saponacei; "slimy milk" is caused by the micrococcus viscosus, and others; "salty milk" is derived from cows suffering from inflammation of the udder, and pyogenic cocci also cause this condition. "Fishy butter" is not due to any specific germ; it is due to the growth of many varieties of bacteria. Bacterial contamination may occur at the milking-shed and be further propagated in the course of the milk through all its stages until it attains its final condition in the form of butter. An organism identical with the bacillus of bleisch, the butyric acid bacillus, the bacillus prodigiosus, and others, communicate a "fishy" taste and odour to butter. Pasteurized butter, free of foreign taste, when inoculated with these germs, develops a "fishy" odour and taste.

The remedy for this evil lies in cleanliness and efficient methods of dealing with the milk from the time it leaves the cow until it is turned into butter.

Examinations at different times were made to estimate the number of germs in samples of milk, and the numbers varied according to the age of the milk, season of the year, and conditions under which the milk was kept. In summer, milk kept at room temperature, when six hours old, contained 500,000 germs per cubic centimetre, and, when 24 hours old, contained 7,000,000 germs per cubic centimetre. In winter, samples were found to contain 50,000 germs when six hours old, and 2,000,000 when 24 hours old,

Experiments with boracic acid and formalin.—The first of the results of a projected series of experiments with boracic

acid and formalin to determine their effects on the health of birds and animals is briefly mentioned. The experiments were conducted with fowls and pigeons, and consisted in the sub-cutaneous injection of the drugs. By sub-cutaneous injection a more certain physiological effect is assured than if the drugs were introduced into the system of the birds by the stomach. Preliminary to the injection of the drugs, the weight and temperature of each bird were taken daily for several days, and, on several occasions beforehand, the blood corpuscles were counted and the hæmoglobin estimated. In the blood of healthy fowls and pigeons there are about 4,000,000 corpuscles in every cubic millimetre of blood. In pigeons the amount of hæmoglobin is a little higher than that of average normal human blood, but in fowls it is only 68 per cent. of the amount in human blood.

The preliminary part of the experiment was commenced on 20th July, and terminated on 1st August. On 1st August the injections began and were continued for ten days, when they were left off for nearly a fortnight. On 24th August they were renewed and continued for a week longer.

Three fowls and two pigeons were employed in the experiments.

No. 1 fowl received at each injection 2 minims of formalin.

No. 2 fowl received at each injection 2 grains of boracic acid.

No. 3 fowl was reserved as a "control."

No. 1 pigeon received at each injection 2 grains of boracic acid.

No. 2 pigeon received at each injection 2 minims of formalin.

Table I. furnishes an account of the results obtained during the period preliminary to injections, and extending from 20th July to 1st August.

Table I.

Birds experimented on.	Average body temperature.	Average weight.	Average number of corpuscles per cubic millimetre of blood.	Average amount of hæmoglobin.
No. 1 fowl ...	107°	4 lbs. 4 ozs.	4,090,000	68 per cent.
No. 2 fowl ...	107°	6 lbs. 4 ozs.	4,050,000	68 per cent.
No. 3 fowl ...	107°	5 lbs. 8 ozs.	4,050,000	68 per cent.
No. 1 pigeon	107°	12¼ ozs.	4,100,000	105 per cent.
No. 2 pigeon	107°	13 ozs.	4,100,000	105 per cent.

Table II. furnishes an account of the results obtained during the period extending from 1st August to 10th August, when injections were daily given.

TABLE II.

Birds experimented on.	Average body temperature.	Average weight.	Average number of corpuscles.	Average amount of hæmoglobin.
No. 1 fowl ...	107°	4 lbs. 9 ozs.	4,080,000	68 per cent.
No. 2 fowl ...	107°	6 lbs. 2 ozs.	4,050,000	68 per cent.
No. 3 fowl ...	107°	5 lbs. 6 ozs.	4,040,000	68 per cent.
No. 1 pigeon	107°	12½ ozs.	4,100,000	105 per cent.
No. 2 pigeon	107°	13¼ ozs.	4,090,000	105 per cent.

On the 12th August No. 2 pigeon died from pneumonia.

On the 25th August No. 3 fowl died from pneumonia.

On the 19th September No. 2 fowl died from pneumonia.

At the beginning of November both No. 1 fowl and No. 1 pigeon were apparently in perfect health. On that date No. 1 fowl weighed 4 lbs. 6½ ozs., and No. 1 pigeon 12½ ozs.

In so far as it concerned body temperature, weight, number of corpuscles, and amount of hæmoglobin, the results obtained in No. 1 fowl, No. 2 fowl, and No. 1 pigeon during the period extending from 24th August to 31st August were practically the same as those obtained during the period 1st August to 10th August. The birds were kept caged up during the whole time the experiments were in progress. The result of the experiments would serve to show that the subcutaneous injection of boracic acid and formalin does not disturb the health of pigeons and fowls.

REPORT BY SUPERINTENDENT IN LONDON OF VICTORIAN EXPORTS.

(*J. M. Sinclair.*)

In reply to the request made that a statement should be furnished regarding the business done in this branch during the past twelve months, I have much pleasure in supplying it.

A portion of the work in connexion with this office is in supplying information, regarding the export trade of the colony, to persons or firms desirous of opening up direct business in the importation of Victorian products. Particular attention has been given to this, and full information is always supplied to every one applying, either personally or by letter. In connexion with this, the exhibits of Victorian products in the show-room attached to the office have been of material assistance.

Another important part of the business of my office is to furnish information in regard to the agricultural, horticultural, viticultural, and dairying resources and capabilities of Victoria, to intending settlers. Every year considerable numbers of persons with capital leave the United Kingdom for the United States, Canada, and other countries, with a view of entering upon agricultural pursuits. Many of these are possessed of sufficient capital to enable them to purchase improved lands. The Canadian Government, by the issue of handbooks, and by supplying information through every possible avenue in this country, makes a special effort to attract farmers to settle in the Dominion. Each settler of this description is of special value in a new country. In 1897 I suggested to Sir George Turner, during his visit to London, that a readable well-illustrated handbook of Victoria should be prepared for distribution, so that the colony and its agricultural and mining resources might be advertised in a better manner. He gave instructions for the preparation of this book, and in the end of 1898 a large number of copies were forwarded. During the past year I have been issuing these as rapidly as attention to other business would permit. I sent a copy of this publication to every library, mechanics' institute, and public reading room, including those in country villages, in the United Kingdom, nearly 2,500 copies being posted. A copy was sent to every

Chamber of Commerce. The library of every steam-ship owned by the P. and O., Orient, Lund, Aberdeen, and White Star lines were also furnished with a copy.

I wrote to the secretaries of 207 Agricultural Societies in Great Britain and Ireland, and obtained from them the names and addresses of 33,000 farmers who are members of these bodies. Of the larger edition of the handbook about 5,000 copies have been posted to these farmers, and I am now sending out 10,000 of a smaller edition. About 2,000 copies have also been applied for and supplied from the office. A large number of teachers have applied for copies for use in schools. Each book sent out contains a circular (a copy is attached) stating that further information can be obtained at the Department's offices in Leadenhall-street, London, and that samples of Victorian products are on view in the show-room attached. As a result of the issue of these books, I have received a large number of letters asking for further information regarding land, products, exports, &c., from persons who contemplate emigration, and have also had a great many personal inquiries at the offices, and a number of persons with capital have gone or intend going shortly to the colony. The show-room, with exhibits of grain, wine, wool, dried and canned fruits, models of green fruit, silk, oils, tabacco leaf, &c., and photographs of vineyards, orchards, butter factories, &c., is of great service in assisting in the direction of convincing persons calling for information, in connexion with this part of my work, of the variety and wealth of the agricultural resources of Victoria. The general ignorance in regard to this is often quite surprising. In furtherance of this part of the work of this office, it is desirable that the colony should have a collection of exhibits at three or four of the principal Agricultural Societies' shows held throughout Great Britain during the summer months, and at these a supply of handbooks should be available for distribution.

Each week during the year I have written and forwarded to the Department reports giving prices and statement of general surroundings of market in frozen produce, butter, fruit, grain, &c. In addition to these market reports, I have written and furnished the Department with 123 reports or letters dealing with fruit, grain, tobacco, pulp, preservatives, meat, live stock, &c., many of these containing matters of interest to the producers of the colony.

Part of my work has also been the inspection of all shipments of butter, meat, fruit, &c., exported through the Department, in order to see that the conditions of contract of shipment are carried out, and that the produce is landed in good order. In connexion with this, I have personally inspected all shipments arriving by 86 steamers during the past year. These steamers arrive at docks situated from 10 to 25 miles from the city, and in order to see the produce being discharged, it is sometimes necessary to make two or three visits to one vessel. This takes up a considerable amount of time. In connexion with this inspection, I have been able to obtain a thorough knowledge of the conditions under which our perishable products should be carried, and from time to time have been able to make suggestions in regard to improvement in stowage, &c., and in the case of fruit alterations in temperature to suit the requirements of various varieties, the result of giving careful attention to condition of shipments during the past four years of my service in this country. No detail in connexion with these matters has escaped attention. Should any shipments of products arrive in a damaged condition, the matter is at once reported by me to the shipping companies concerned, so that it is promptly investigated, and if the fault is due to any carelessness or neglect on the part of the employés on the vessel they can take action to prevent recurrence. The various shipping companies carrying produce consigned through the Department have always shown themselves anxious to carry and deliver it in good condition, and on every occasion have given me every opportunity and facility to make an inspection of our shipments. When at the docks, if I observe any carelessness in the handling of our shipments of perishable products, or neglect in exposing them in either hot or rainy weather, in such manner as to cause damage, I at once report the matter to the Dock Company's officials, and have these matters given attention to. In everything relating to condition and discharge of produce shipped through the Department, I do all in my power to safeguard and protect the interests of Victorian producers.

Reports on the condition of every shipment arriving are furnished each week to the Department, and if any details can be suggested for improving the system of transit or carriage of our products these are noted and also furnished. It is only by seeing and studying closely details (which may

seem insignificant, but in reality are great factors) of condition and surroundings of cargoes of perishable products arriving after a long voyage, and having also a previous knowledge of their production, handling, packing, stowage, shipment, &c., that reasonable ideas can be formed, or conclusions arrived at, respecting what should be done to improve methods of transit. Australia is so situated that a long passage, with wide climatic variations, has to be provided for in shipment of products, such as fruit, wine, tobacco, &c. to Great Britain, and producers and shippers in Victoria require to pay strict attention to every detail in connexion with selection of products, and their soundness of condition, also packing, stowage, &c., in order to insure their delivery in sound and perfect order.

In addition to the foregoing, I have frequently to furnish information to Victorian exporters or producers respecting outlets for products here, or to place them in communication with reliable firms with whom they may do business in this country. In this way this office has been of service to many who visit this country on business, or write from the colony.

During the past four years I have made a careful study of the whole surroundings of our trade in agricultural products with the United Kingdom, also that of those in competition with us. My previous travels in the United States, Canada, South America, and various Continental countries, and the opportunities I have had of studying the surroundings of production there, have been of great service to me in connexion with obtaining a grasp of trade and competition in this great world market.

REPORT BY THE PRINCIPAL OF THE SCHOOL OF HORTICULTURE.

(*C. Bogue Luffmann.*)

The school is designed for the teaching and training of orchardists, gardeners, and managers of fruit-growing and small private estates. It is situated in a near suburb of Melbourne, and has a good tram and train service.

The estate comprises upwards of 40 acres of varied land, of which twenty are at present devoted to fruit trees, vegetable culture, a nursery, and flower gardens.

New stables, plant houses, frames, sheds, and other buildings have recently been erected. Class, dressing, luncheon, and work rooms form portion of a large pavilion, wherein shelter and occupation are found in adverse weather.

Class-room instruction is given in horticultural science, vegetable pathology, botany, chemistry of soils and plants, physical and commercial geography, entomology, measuring, levelling, designing and plotting of homesteads, orchards, and garden areas, and the most approved methods of raising and managing fruit trees and plants. Practical work includes the propagation and management of orchard trees, citrus, table grapes, bush fruits; harvesting, storing, packing, marketing, drying and canning of fruit, vegetable culture, clearing, grading, and trenching of land, management of soils, manures, drainage, water conservation and distribution, irrigation, villa gardening, and care of domestic animals.

Rules for Admission.

Students of both sexes are admitted—youths over fourteen and women over sixteen years of age. Students may enter from one to three years. Those taking the full course and passing the necessary examinations are granted a diploma and recommended to suitable positions. Male students are enrolled at any time, but it is advisable to join at the commencement of the year. Instruction is free. Male students deposit £5 as a guarantee for their good behaviour. Students leaving the school within one year forfeit their deposit money.

Women students attend thrice weekly from 2 to 5 p.m. Male students daily, except Saturdays, from 9 a.m. till 5 p.m.

Women students have to provide themselves with the uniform dress and pocket tools. Diaries must be kept, and approved text-books purchased by all students. The year consists of a ten months' course—February to December. All students must strictly conform to the rules of the school. Students are non-resident, but good accommodation exists in the locality. Applications for admission should be made to the Secretary for Agriculture, Public Offices, Melbourne.

The year opened with thirteen male students ; one death occurred, and one student completed his course of three years, and was placed on a large fruit-growing estate in Queensland.

A feature of the year has been the opening of the school to women students. In February 72 students were enrolled, upwards of 40 entering for the full course. These have been taught designing, forming, and maintaining villa gardens ; vegetable culture, and the general management of orchard trees. Several orchard blocks have been pruned by women students, and they have also been successful in other branches. The essays sent in (upwards of 50) afford ample proof of the capacity and earnestness of the students. Many of the papers are so good that it has been deemed advisable to include examples in an appendix to this report. The final examination, in which 62 students took part, comprised a list of 30 subjects. The result was highly creditable, one student obtained 149 out of a possible 150 marks, four others 140 marks, and 27 over 120 marks.

Two or three junior boys gave proof of a good capacity for horticultural work, and the women students succeeded remarkably well, when it is borne in mind that they received only bi-weekly instruction.

The result of the year's work is extremely encouraging, and now that the possibilities of this institution are fully recognised, an increased number of students will be attracted to it, and the teaching they receive must produce good results in improved methods of culture, handling of fruit, and horticulture generally.

The course of class-room instruction consisted of 150 lectures, illustrated by various drawings, diagrams, and living subjects. (For examples of lessons see Appendix.) All class-room instruction has been regularly supported by field demonstration and practice, and, as a consequence, many students have become as proficient in carrying work

to a successful issue in the field as in writing an essay on the same. Students are taught to know the meaning and value of every operation on the soil or plant.

Class-room teaching has embraced all the work of the year, and has been strictly in accordance with local conditions, resources, and market requirements. The comprehensive nature of the subjects dealt with may be gathered from the essays and examination papers. (See Appendix.)

The practical work of the year has been extensive, varied, and thorough—including the grubbing, clearing, grading, draining, trenching, manuring, plotting, and planting of land for various trees and crops. Also the formation of and renovation of lawns, shrubberies, and borders. The mode of forming, developing, and maintaining of profitable design in various fruit trees, has been systematically practised, and the citrus family and the grape vine dealt with in accordance with their needs in this colony.

Grafting, budding, and various methods of propagation have been carried out at suitable seasons.

Vegetables have been grown on an extensive scale, as these, having to pass through various stages of growth in a brief period, are a fertile source of instruction to the student.

The treatment of soil and plants for the prevention and cure of disease has been regularly taught and practised. Extensive reforms and additions have been made to the working plant, orchards, and gardens. A drainage system has been instituted, together with manure and litter-saving pits, so that the greatest economy may obtain in conserving heart and value in the soil.

Upwards of 500 fruit-growers have called for instruction in various branches of orchard work, and about 600 letters on subjects of horticultural interest have been sent to inquirers during the year.

New and standard varieties of fruit have been distributed in early autumn and late winter months.

The fumigation of trees, under the Vegetation Diseases Act, has been carried out at the school.

Several applications have been made for students as managers of fruit-growing estates and directors of private gardens, and it is evident that there will be no difficulty in placing those who are fully qualified.

Subjects for Competition, 1899.

Senior Students.

1. Essay: Value of grading, draining, manuring, and regular cultivation of the soil. (Three to four pages foolscap.)
2. Essay: Select twelve most profitable fruits, stating districts in which they can be grown, and what markets are open to them.
3. Essay: The objects of winter and summer pruning of deciduous fruit trees.
4. Practical work, most skilful preparation of soil, planting and pruning of trees.
5. Principles of horticulture and vegetable pathology.
6. Botany applied to horticulture.

Junior Students.

1. Essay: Principles of pruning established apple, peach, and lemon trees. (Four to six pages foolscap.)
2. Essay: Mode of preparing and maintaining fertility in soil, Victorian lowlands. (Four to six pages.)
3. Essay: Six worst local pests (animal) with remedies. (Four to six pages foolscap.)
4. Oral examination in fruits of commercial value.
5. Best collection of injurious insects and fungi.
6. Competition in hoeing, raking, and digging.
7. Best forecast of work to be done from week to week.
8. Most regular and punctual attendance and interest displayed in work.

Women Students.

1. Essay: Lemon Culture. (Four to six pages foolscap.) Points—Best class of soil, preparation and maintaining of soil, situation, climate, moisture, stocks, best sorts, forming young trees, pruning trees in bearing, cleaning, harvesting, markets open, &c., &c.
2. Essay: Table Grape Culture. (Four to six pages foolscap.) Points—Site, class of food necessary, preparation of soil, mode of planting, training, pruning, management of wood, varieties, mode of protection, &c., &c.
3. Essay: How to choose, prepare, and maintain fertility in orchard and garden soils (Victorian lowlands). (Three to four pages foolscap.)

4. Essay: Asparagus and any other three vegetables, culture of. (Four to six pages foolscap.) Points—Choice of site and soil, depth of soil necessary, mode of planting, and general management.

5. Essay: Principles of Villa Gardening. (Four to six pages foolscap.) Plan in accord with climate, size, capital available, &c., &c. Villa front, 60 feet x 60 feet, or 80 feet x 40 feet, to be planned.

6. Practical illustration of hoeing, raking, and digging with fork and spade.

7. Practical illustration of pruning—Apricot, Peach, and Apple.

8. Practical illustration of pruning unstaked and trellised vines.

9. Special prize: Most able examination papers.

N.B.—All essays must be original. The substance of lectures and general discussions will be admitted, but copying from the text-books, standard works, or newspapers, or the inclusion of matter foreign to the subject of any essay will disqualify.

Three or more students must compete in each subject, or no prize will be given.

The value of any prize will correspond with the value of the essay.

THE PROSPECTS OF COMMERCIAL FRUIT-GROWING IN VICTORIA.

(By C. Bogue Luffmann.)

Fruit-growing does not pay: so say the inexperienced who have tried it and failed. And in one sense they are right, for fruit-growing can never become a profitable industry until it is regarded as a business to be learned before being entered upon. When the principles and practice of the craft are well understood, and industry and natural capacity are brought to the work, success is sure.

The first thing to be considered is, what the world local and over-sea wants; next, how far it is possible to produce at a price which will defy outside competition: hence a knowledge of the producing and consuming areas of the world is indispensable to the commercial fruit-grower. If it is intended to produce for the local market alone, there is still the necessity for considering the competition which may have to be met from foreign or inter-colonial producers. What may be termed the comparative value of the resources of this colony must be clearly understood, as starting "on the blind" will prove not the worthlessness of the business, but the ignorance of those making the venture.

Victoria now produces more fruit than her population requires, it is therefore necessary that foreign markets be found. These markets are not numerous, but they are large enough to absorb far more fruit of certain kinds than united Australia will be able to supply for generations to come.

The populations and wealth, and hence the purchasing power, of the northernmost old-world countries are constantly on the increase; the favorable areas of production are eternally limited, and must form the permanent sources of supply. Victoria lies within the producing zone for those fruits which bulk largest in the trade of the wealthiest European and Asiatic nations. Her rivals in trade are poorer, able to work at a much lower rate of pay, content with a smaller trade profit, more expert in the art of production, and nearer to the consuming markets. Against these must be placed, as disadvantages—taxation of the heaviest description, costly land and no means to extend their areas, inability to purchase, or capacity to use, modern

A GROUP OF STUDENTS.

and expeditious implements and machines, impoverishment of land, or lack of water, political disturbances, and, in some instances, incapacity for combination towards the furthering of foreign trade.

Victoria has for established rivals in the fruit trade, Southern France for prunes and bottled fruits; Spain for muscatels, raisins, sultanas, figs, oranges, lemons, almonds, dried apricots, table grapes; Italy and Sicily, oranges, lemons, almonds; Turkey, figs, sultanas; Syria, figs, oranges, almonds, dried apricots, sultanas; Bosnia, prunes; Greece, currants, almonds. These fruits are all naturally adapted to the geographical position and mean elevation of Victoria. Apples, pears, plums, cherries, and bush fruits are already a large source of profit, and succeed best in the more southerly, high, or best watered areas. Our conditions are foreign to those of our race, and our practice should conform to the methods of Southern Europe, rather than to those on the line of London, Paris, and Berlin.

Beyond a general knowledge of markets, the orchardist should be well informed as to the native wants of various fruits, and the opportunities which exist for their perfect development on a given area. In brief, he must be able to show that his own capacity, the soil, and situation, and the wants of the tree are in perfect accord. It is by bringing full and exact knowledge to operate upon naturally favorable areas that success is achieved. A popular fallacy exists that fruit will grow anywhere and anyhow in this colony. Nothing of the sort. We need the "eyes" of the country for those fruits most in request and profitable when grown. The fruit industry will make a permanent advance when we form a true estimate of our natural resources. Man succeeds when nature is on his side. It is ignorance, conceit, or youthful impetuosity which attempts the conquest of the desert. The influence of climate on soil, and on the fruiting powers and durability of fruit trees, are not sufficiently recognised. It is common to see fruit trees, of all kinds and degrees of vigour, placed in positions entirely out of correspondence to their native wants. The climate of Victoria, though more favorable to the production of the leading commercial fruits than any other of the Australian group, is, on the whole, a hard one, as is shown by the fact that nearly all orchard trees age prematurely, and die, or decline rapidly, if left untended. In further proof—excepting in rare situations—they will not

exist in a wild state. We learn from this that all domesticated fruit trees must be well placed and systematically cared for. Early maturity implies early decline, and the mistake is made in supposing a soil or district well suited to fruit trees because they grow quickly and produce early crops. A tree to be profitable must yield at least ten or twelve full crops of good quality fruit. Bad seasons will occur as the result of frosts or other climatic disasters, or of unskilful treatment. Allowing four or five years in coming to maturity, the necessary length of life will be twenty years. Of course, with certain kinds well placed, it will be much longer, and yet the average life of useful fruiting trees in Victoria is under twenty years. Herein lies a most important fact—every generation must plant for itself. Greater proficiency might extend the period, but the fact will eternally hold good that, use what skill and industry we may, every 20 or 25 years will see an entirely new lot of trees. It would therefore, be fatal to suppose that, the colony being well stocked with orchards, further planting is risky and unnecessary. Supposing the acreage under bearing trees to be 40,000 (it is much less) it would require an annual planting of 2,000 acres to maintain the existing supply, to say nothing of the increase which we are justified in encouraging. Admitting that a market exists for well-grown fruit, the most favorable methods of production and disposal have to be considered. An intelligent specialization of fruits in different localities is indispensable. Much-mixed orchards and small parcels should not be tolerated, where it is known that one or two kinds of fruit are well suited to a district, and the market is sure.

Bordeaux is famous for its prunes. Messina for its lemons. Malaga for its raisins. Smyrna for its figs. Seville for its olives. Each has a soil and natural set of conditions conducive to the greatest perfection of fruit, plus a people possessed of exact and uniform experience, largely intuitive, from long acquaintance with the subject. Victoria, in the same way, in so far as the soil and general conditions are uniform, would gain by having its peach, apple, pear, prune, or citrus districts. Where any form of labour becomes general in a community, defects are quickly eradicated, and the necessary knowledge remains as an inheritance for the young. These, starting from safe premises, succeed, and thereby give permenance to the industry.

The members of many old-world communities are joint-owners of buildings and implements necessary to the expeditious handling and storing of their produce. It is well for the individual to be self-contained, but the permanent value of fruit-growing in any locality depends on limiting the number of fruits grown, and adopting methods of cultivation, preparation, packing, and marketing of a uniform character. The producer of good material brings the market to his own door, as he is not put to the expense of hawking his wares, but can attract the trader to make purchases on the spot. The average man of small means and experience cannot secure the same measure of success from working alone that would come to him by combining with others.

Little reform can be hoped for on the part of existing growers who are widely scattered, and in the majority of instances are not entirely dependent on their orchards. It is with future work that we are most concerned. Here we would plead for a new order of producers (1) combinations of small growers, equipped to produce and dispose of their produce on the lines of the dairy-factory system; and (2) the merchant producer, who, having the means, only awaits the arrival of the skilful manager to assist him in the production of the raw material.

In France, Italy, Spain, and lesser communities on the Mediterranean and Adriatic, the merchant fruit-grower is a recognised and much-valued institution. He usually owns a considerable estate. He has liens and agreements to take the crops from many others. His larger knowledge and command of capital enable him to raise the best possible class of fruit from the local soil. The rules he lays down to be observed throughout every operation are known to all. All labour is classified, so that the most expert obtains in every operation. A working plant to turn every particle of material to account is here possible. Cider, vinegar, canned, dried, pickled, and preserved fruit are the profitable by-products of any large fruit-growing estate. The manager with exact knowledge, industry, and economy will show a profit. Victoria needs this class of man sorely; as, given men with ability to initiate and carry work to a successful issue, capitalists would not be wanting to enter upon the work of production. The future of the fruit industry depends, almost entirely, on the amount of intelligence and organization devoted to it.

We shall secure no good markets until larger quantities of higher average quality are produced from compact areas. Fruit-growing for profit demands more or less knowledge of the physiology of plants ; the causes of health and disease ; the nature and functions of the different parts of trees ; the effects of climate on vegetation ; the nature and variable composition of soil, and the effects on soil of heat, air, frost, water, light, manure, lime, and other chemical substances ; draining, cultivating, weeds, neglect, and crops ; familiarity with seasonable periods for every operation, harvesting, and marketing ; acquaintance with fruits of commercial value ; capacity ; industry ; to say nothing of detail which takes years to acquire and fix in the memory. If the foregoing are indispensable, it is presumptuous to regard commercial fruit-growing as a refuge for the ignorant.

Our first concern is to reduce existing material to proper order, to diminish, from year to year, the variety of fruits in each district ; mere collections of sample lots being reserved to the amateur ; to encourage the peach grower to go to the peach area, the citrus, or apple grower, to where these fruits are grown to greatest perfection, so that we may, as soon as possible, insure a steady market through combination and improved methods.

Fruit-growers should not isolate themselves. This has been the ruin of hundreds, and it will produce a majority of failures so long as it obtains.

The orchardist in a small or large way, should start with, or be able to command, skill and experience. If he has not these, let him work, learn, and then start. His reward will come sooner, and remain to him. If a fruit is good and marketable at a paying price, is suited to the soil and situation, and its cultivation is understood, let him stick to it, and get more, providing he has strength to do more work.

The prospects of commercial fruit-growing in Victoria are favorable to those who start with a sound knowledge of the industry.

IN THE LECTURE ROOM.

CULTIVATING VICTORIAN ORCHARD LANDS.

(By C. Bogue Luffmann.)

Why do we cultivate?—

I. To clean the soil of weeds, which rob it of food and moisture.

II. To rid the land of various injurious insects and fungi.

III. To break up the hard hot surface, which hastens evaporation and prevents aëration.

IV. To free food stuffs lying in the soil.

V. To preserve an earth mulch, and so reduce the temperature and conserve moisture in the summer.

VI. To prevent impurities from souring the soil in winter.

VII. To enable water to permeate all the soil and carry food to the roots.

These are the ordinary and direct reasons why we cultivate in a dry hot climate. Capillaries, or tubes—due to contraction and expansion, and dependent on the degree of moisture and temperature of the air—exist in all but extremely sandy and dust-like soils. If these tubes are broken near the surface we prevent the escape of moisture.

Cultivating exposes a large proportion of soil to the air, hence it is sweetened. Orchard trees can thrive only where soil is in a free, sweet, and active state. There would be no growth of the roots—on which all the superstructure of the tree depends—did not the soil make a regular physical movement. All the food stuffs in the soil are quickened and made available by the presence of air, water, and heat. Decomposition and recomposition are constantly taking place in the calm and seemingly passive earth. In this sullen surface soil there is eternal change, bustle, and reform. Where it is not so nothing of value can grow.

All vegetable life may be described as the outcome of fermentation. This implies that all fruitful soils (in warm climates) are fermenting continually. In so far as this takes place, food stuffs are made available to the roots of plants. All sour soils are masses of fermentation, interfering with the

growth of trees. Therefore, *violent* fermentation should not take place in the soil of the orchard. All sour land holds much plant food, but the sourness must cease, by means of elaborate cultivation, ere good results may be hoped for. Lime is most useful in sweetening sour soils, as it not only destroys the small life which promote this sourness, but also warms the soil, and thereby extends the growing period of the roots in winter.

The heavier and more moist the soil, the more frequently must its surface be dealt with—as all moist, close soils soon become sour, and exposure to air (combined with drainage) is the natural mode of sweetening them. Lime, by acting chemically on the soil, changes its foul particles into sweet edible substances for the roots of trees. Ashes, sand, and gravel also help in a more moderate degree, by keeping the soil open, and thus admitting air.

All domesticated fruit trees are healthy and profitable in proportion as they receive air, heat, light, moisture, sweet soil. All these, except light, are controlled by cultivation, and even where a soil is good, it cannot furnish useful crops without them. These five subjects, not exactly of the soil, are necessary to the production of all vegetable forms, the amount required by each differing only in degree.

Cultivation liberates, gathers, conserves food for plants. I. It liberates, by breaking clods and bringing different elements together, which apart would not form plant food. II. Cultivation gathers much light matter on the surface, which would otherwise be desiccated and blown away. III. Cultivation conserves—by retaining moisture to act on and prepare food stuffs during summer, and also by preventing weeds from using up the free properties of the soil.

Cultivating alone is a genuine means of enriching soil. Poor soil is made more fertile, and rich soil needs cultivating in order to keep down objectionable matter, such as rank weeds, which choke and foul it.

All orchard trees in dry climates require frequent and thorough cultivation.

In the cold European countries, orchard trees usually occupy damp meadow-like land; hence many argue that grassed orchards should succeed here. But similar *conditions* are rare in Victoria.

Where the climate is cool and moist, grass, growing all the year, provides a permanence for earth worms, and these

make myriads of tubes between the surface and the sub-soil. These tubes admit air—they carry down various elements which have been sweetened on the surface, and so secure health to the roots during summer. Under such conditions of climate, a most elaborate system of cultivation is performed by insects. In winter, these grassed orchards are saved from sourness by the perishing and cleansing frosts. The temperature falls so low that the bacteria, which foul the soil, are held in suspense; hence the soil of cold countries is, during winter, sweeter and more acceptable to the roots of trees than that of the temperate regions, where moisture combines with sufficient heat to favour the developing of much noxious matter.

Climate governs all our operations. Here a so-called grassed orchard would soon become hard as a brickfield, and a home for all orchard pests.

There are abundant examples of this fact. The importance of thorough and intelligent cultivation can never be overstated, as the tree depends entirely on the condition of the soil.

Cultivation has literally produced all the splendid vegetable forms which man enjoys. Think for a moment how little *wild* food man consumes in the cold and temperate zones. There was a crude sufficiency when he was a savage, but, with the coming of civilization, or living by artifice, the nature of his supply has changed completely. He cultivated something like the tiny hawberry till it became an enormous pear ; he dug round the primitive cabbage of half-a-dozen thin leaves until we have it as large and solid as a scuttle of coals. And so on throughout the multitude of plants man has subjected to his use. He has been feeding them, amid congenial surroundings, and they have grown.

Orchard lands should be cultivated in accord with their nature—as affected by climate—and the specific needs of various trees. All lands should be dealt with often enough to insure a perfectly free clean surface during summer, and to provide for the easy movement of roots at all seasons. The depth at which to cultivate depends on the nature of the soil, age, and nature of trees. Example.—Young trees cannot grow too fast; hence, cultivate to assist them in every possible way. With the trees established, and an inclination to make wood at the expense of crop, lighter cultivating —mere cleaning of the surface—would serve for a time, though, of course, the orchardist must discriminate between checking and starving the roots.

Soil Treatment the Year Round.

Mid and Late Summer.—In January we should find a clean loose surface. Preserve this by light cultivating, harrowing, or roller-disc work at short intervals. As trees are relieved of their crops fork up the hard patches formed around them.

Autumn and Winter.—In autumn a crop of weeds is almost unavoidable (though docks, couch, sorrel, and other perennial weeds must never be allowed), and in dry hungry soils they are to be desired, as they furnish humic matter, which assists in conserving moisture in summer. It is bad practice to plough heavy crops of weeds into badly drained and "slow" soil, as it produces sourness and injures roots. Heavy weeds should be mown and allowed to wilt, or better still, carted into a pit, rotted into a sweet mould, and then returned to the orchard.

If weeds are mown and raked up after the fall of the leaf the soil is kept warmer and sweeter as desired for peaches, apricots, cherries, and other trees sensitive to cold and wet.

Good cultivation prevents extremes of heat and cold, drought and moisture ; therefore, cultivate to warm the winter soil. After pruning, plough deeply, away from the trees, cultivating or cross-ploughing again soon if soil runs together or weeds grow apace.

The object of winter cultivation should be to keep the ground open, warm, and sweet, able to receive and hold water in a dry warm district, and to prevent flooding and stifling of the roots in a cool region.

All the surface of an orchard must be dealt with in winter. A hand fork is the best tool to employ within the spread of the trees.

Spring and early summer.—In spring, reverse the ploughing, throwing the soil towards the trees, and cultivate, roll heavy lumpy soil, and harrow in regular order. Don't allow any weeds to grow at this season, or the soil to become hard and dry on the surface. No deep cultivating should take place in a dry district during the late spring or summer, as this has the effect of wasting moisture. Only where heavy and penetrating rains fall is it advisable to plough or cultivate deeply during summer.

Learn what plants like, and how to gratify their taste, and you have mastered the art of cultivating the soil.

RESIDENCE OF THE PRINCIPAL.

THE ECONOMY OF DESIGN IN FRUIT TREES.

(By C. Bogue Luffmann.)

The substance of this paper, with numerous black-board and living illustrations, was given at Burnley to show the value of design in the framework of fruit-bearing trees. It does not deal with pruning in the ordinary acceptation of the term, as it stops with the shaping of the framework or foundation wood; but, as longevity and an annual and abundant supply of high quality fruit depend entirely on the design of the tree, all orchardists should be conversant with this important subject.

The design of any fruit tree is not merely its outward form, as "Goblet," "Pyramid," "Half Globe," &c. It has an *interior structure*, on the nature of which depends its commercial value.

Every one dealing with trees for profit should know the functions, instinctive habits, and value of all their members. A tree above ground is composed of five more or less permanent parts; that is, excepting its leaves, flowers, and fruit. It has—

I. A trunk; from which proceed
II. Main branches; from the mains spring
III. Secondary branches; from the secondaries grow
IV. Laterals; and from these
V. Spurs or shoots.

Fruit is borne on the latter types only, though they do not spring solely from the laterals, but may be produced direct from the secondaries, and, to an unimportant extent, on the main branches of some trees.

No matter what the variety, age, or type of a standard tree, these five kinds of wood compose its head, and the orchardist should know the suitable position and proportionate size of each part. All fruit is borne on light wood only, therefore this must be generally distributed throughout the entire head (saving the main branches). The spur, or shoot, is dependent on a certain amount of light and air for the development of its buds, their subsequent blossoming, and perfecting of fruit. It is also fruitful or fruitless, breaks into wood, or remains dormant, according to the volume of sap sent to it, and the size and vigour it acquires.

All buds are, at an early period in their existence, in an indeterminate stage—that is, they may develop into flower or wood buds, according to the supply of sap, air, and light they receive. It is a common law of nature for the sap—which is the sustaining and wood-forming substance of the tree—to make the strongest growth where it ascends perpendicularly. Upright growth is, therefore, woody. It is weakness rather than strength which induces fruitfulness, and herein lies the clue to a profitable design. It lies between coarse strength and extreme weakness.

As upright growth is usually too strong to bear fruit, so all wood at a sharp angle from the perpendicular to the horizontal and dependent is more and more inclined to be fruitful, owing to the more moderate supply of sap resting about the buds, and the instinctive weakness of the part.

If upright growth is to bear fruit, it must be light. The trunk being the medium of supply to the super growth, branches placed directly over it are invariably the strongest, the rule being that they weaken according to the angle at which they stand from the perpendicular. In an economically designed standard fruit tree this law is reversed, the strongest branches ranging on the outside, the others weakening in regular order as they near the centre. By adopting this plan one secures a *permanently* shapely and highly profitable tree, as, where the framework is strong and broad, no difficulty exists in preserving an abundant supply of fruiting wood throughout the entire head; but if, on the other hand, light branches are encouraged on the outside, they fruit prematurely—the strong centre branches draw the sap away to no purpose, further development is impossible, they are quickly exhausted and disappear, leaving the tree in the form of an inverted pyramid, with a close and barren centre, and able to bear fruit over a meagre and unduly exposed exterior.

The size, shape, and fruit-bearing powers of a tree may vary considerably owing to native habit, resources of soil, position, and climate, but the interior economy should be well preserved in all circumstances. An appeal to reason, and the illustrations which, unfortunately, exist in almost every orchard, will show the comparative value of well-designed and irregularly formed trees. We see thick and thin branches of the same age standing at the same angle. One branch with a nest of spurs at its centre, another with

a tuft of spurs at its point, or down one side, the other bare. One side of a tree has three thick branches, the other side six or seven thin ones. Many trees have a fringe of fruiting wood near the crown, the inside being absolutely bare. These are not rare but general defects, in every case due to want of design and intelligent handling.

In every subject, there is a type of wood favorable to the production of fruit, at the least expense to the tree, therefore this type should be evenly distributed throughout every part except the main branches.

Where it is in the nature of a tree to make lanky pole-like branches these must stand well nigh perpendicular, and be of moderate length, or they will not support their crops, and preserve a fixed position. Every branch should be so placed, and given such a degree of vigour, that it will adhere to one position at all seasons, no matter how heavy the crop or wild the storm.

The difficulty of arranging branches is overcome when the resources of the soil and the native vigour and habit of any subject are thoroughly understood. Very few branches are needed, if they are well spaced. Three mains will yield nine secondaries—three light ones inside, and six of much greater vigour surrounding them. (Nine would prove too many in some trees. The age and spread of the tree determine the number of secondaries. They must always be sufficiently far apart to secure light and air on all sides when in full foliage.)

In designing a tree, it is necessary to note if the strongest secondaries occur on the *inside* or *outside* of the mains. An examination of living trees will show that nearly all peaches throw their secondaries *outwards* from the mains. Apricots are inclined to spread laterally. Apples and pears are most diverse, each variety calling for separate investigation.

Where secondaries spring *outwards* it is necessary to carry the mains higher and more perpendicular than when they spring from the inside. But the mains must not be laid in hurriedly, or the sap will be carried to the points, and thus prevent the formation of strong secondaries at base.

Where secondaries spring from inside, the mains are arranged as low and near the horizontal line as they can be conveniently carried without producing weakness and premature decline. Again, strong-growing varieties have their mains and secondaries at a sharp angle to the trunk, whilst weak and limp wood will modify the size of tree and call for more upright growth.

Carry all types of wood on uniform lines. Examples—All mains of equal size, length, and angle from trunk; all secondaries light in the centre and gradually thickening towards the outside; all laterals, shoots, and spurs strongest at the base of a branch and weakening as they ascend to the outside of the tree. All spurs and fruiting shoots at regular distances, established and growing wood alternating, otherwise there must be a feast and a fast through overcropping, or impotence of the light wood.

It is too much to hope that these rules will be literally observed by all orchardists, but the object is to explain the reason why fruit trees should be carefully planned and controlled.

The widest part of a fruit tree should be its base, a foot or so above the trunk. If it is objected that horse implements cannot be used and close cultivation secured, the reply is: Increase the height of the trunk, though not beyond 3 feet, as the climate demands low broad-based trees, which will screen their feeding area from the direct heat and desiccating winds of summer. If there is any inequality in the size and position of the mains, they should not be called upon to furnish the same number of secondaries. Example: A strong main may furnish three secondaries; another, considerably weaker or more horizontal, should yield two; the latter will then be of about equal size to the three furnished by the stronger main. A decidedly upright but indispensable main may be called upon to furnish several secondaries in order to exhaust it somewhat, after which a secondary or two of suitable size may be selected, and the others pruned away. Secondaries, again, must, in so far as they vary in size and position, be cropped according to their strength, otherwise the form of the tree will become irregular and less profitable. Laterals, shoots, and spurs are, in the same way, formed strong or weak, long or short, single or composite, according to the age and habit of the tree and the class of fruit desired.

The production and maintenance of fruiting wood is assured when the foundation is properly laid, therefore be particularly careful in dealing with the trees during the first three or four years. The right way absorbs no more money or time, whilst it assures the fullest possible return from all trees where cultural operations are well carried out.

FLOWER GARDENING.

APPENDIX No. 1.

HOW TO CHOOSE, PREPARE, AND MAINTAIN FERTILITY IN ORCHARD AND GARDEN SOIL.

(*By Tessa Smith, First Year Student.*)

The choice of orchard lands is one of the most important matters with which a fruit-grower has to concern himself, and an intelligent selection of site and soil at the outset is the first step towards that success in the industry to which he naturally aspires. The advantages of choosing both a favorable situation, a clean soil and one that is adapted to the requirements of what he intends to grow, can hardly be over-estimated, as it must seriously affect the subsequent success of the undertaking. We will assume that in selecting a site he has made up his mind what he wishes to produce, as that should necessarily influence his choice. If he intends devoting himself to the culture of any particular fruit, he would seek the site and soil best adapted to it; but if, as is more often the case, he wishes to grow the ordinary fruit or vegetables for the local market or for export, a class of soil should be chosen which, with moderate treatment, will bring about the required results. He must consider the climate and its influence on the soil, make himself familiar with all the local conditions and their direct bearing one upon the other, and this knowledge will guide him to a great extent in making a selection.

With regard to the site, let him carefully avoid a dead-level, sun-baked, wind-swept plain, where natural drainage is a thing unknown, and the task of supplying it is rendered doubly difficult; let him also avoid an abrupt hill-side, where, even with excellent natural drainage, there will still be the danger in winter of water washing down, causing a waste of food-stuff, and doing much damage to crops. Gentle undulating country or a mild declivity which is not too exposed to extremes of heat and cold, with unfavorable conditions of climate, will be found most suitable: add to this a deep soil over broken stone which will supply us with natural drainage. It is very necessary in this climate to have a deep soil where there will be more likelihood of moisture being conserved in dry weather, while drainage is one of the first essentials. Deep friable loam is an excellent class of soil and well adapted to most things. It is not half so difficult to maintain as a shallow one, no matter how rich the latter, it will want regular working. If at all moist it has a tendency to become sour, and will need frequent exposure and very efficient drainage; and the

richer it is the more abundantly will rank weeds grow in it; these also will always cause it to become foul, besides giving endless labour to get rid of them. But, wherever the site, and whatever the soil, let him be sure that it is perfectly clean and sweet, and, in order to insure this desirable state of things, begin by a thorough preparation of the soil. In planting a new orchard everything is practically in its infancy, therefore it is all the more necessary that the soil should be perfectly clean, sweet, and sanitary, and the fact of starting with an area free from insect pests and infectious matter of every kind will help him very materially to keep it in that condition afterwards. It is obvious that no better opportunity presents itself of thoroughly sweetening the land than before planting.

In the preparation of the land, clearing is generally the first labour involved, and after the trees have been grubbed out, they and all rubbish should be burnt; then the land should be ploughed and allowed to lie fallow for some time, and exposed to the beneficial influence of climate. Few impurities will survive this direct exposure, and, when a sufficiently long period has elapsed, he can continue operations.

Grading, trenching, and draining are all done with a view to maintaining fertility in the land. By grading, we prove and equalize the soil; for it can be readily understood that only by bringing about equal conditions in the soil can uniformly satisfactory results be hoped for. By trenching, we insure a sufficient depth of cultivation, and can, at the same time, work in the necessary manure and arrange and blend the soils so that the roots will be given every opportunity to move in the class of soil that is most likely to favour their development. By drainage, natural or artificial, the necessary degree of heat, air, and motion is given through the agency of water, which, passing freely through the soil, carries with it these three essential elements. After these have been thoroughly done, he can begin to plant with every hope that with skilful management he will obtain the best results; but the care of the soil must not cease with these first operations, the land should be submitted to a regular system of cultivation, it should be dug and ploughed frequently, and this for various reasons, viz.:—

That the weeds may not be allowed to choke the soil and deprive it of food and moisture.

To expose any impurities to the sun and air.

To enable air to permeate the soil.

To permit of moisture passing through easily to the roots, which it cannot do through a hard surface.

By dint of careful cultivation the fruit-grower will keep the land sweet; but another very important matter has still to be

considered, and that is the feeding of the soil ; here, a knoweldge of the soil, and a familiarity with the tastes of the plants are very necessary. Cultivation alone causes an amount of food stuff to be wasted, sun and wind are continually robbing it, to say nothing of the tremendous amount of nourishment drawn up by the roots to enable the tree to perfect its crop ; and it stands to reason that this supreme effort on the part of the tree must have the effect of draining the soil of the greater part of its resources and leaving it in a hungry state ; hence the great necessity of manuring and watering the ground at this period, that is, after cropping. As to the kind of manure the soil will require, so much depends on the nature of the soil and the character of the crop it is to carry, that it can only be dealt with in a general way ; but in this climate, in the low lands of Victoria, it can be safely said that humic matter is a property conspicuously absent in the soil, and if the orchard area will permit of space to be set apart as a fattening ground, where manure, burnt rubbish, litter of every description, of which leaf mould would form a valuable part, can all be thrown and dug in and allowed to decompose, this, when applied to the orchard land and well incorporated with the soil, will, in a great measure, make up for the deficiency. Lime is another property lacking, and is more expensive to supply, but it is extremely necessary where the soil is at all heavy and moist. In the dry season it is an advantage to mulch round trees, as by this means moisture is more easily conserved. Some vegetables grown in among fruit trees benefit them on account of the chemical properties they impart to the soil, peas, for instance, add nitrogen.

To maintain fertility in the land the fruit-grower should make himself perfectly familiar with the nature of the soil and the requirements of the trees, so as to be able to make up for the deficiencies in the former and gratify the tastes of the latter ; it would be wrong and unprofitable to ignore either ; therefore let him cultivate continually, and, by means of cultivation, he will ameliorate the conditions of the soil ; for it serves the threefold purpose of liberating, gathering, and conserving food for plants, and it is only by recognising its importance that he can hope for success, as the health, vigour, and fruitfulness of the tree depend almost entirely on the condition of the soil, and the most skilful pruning and management will not avail if he neglect to cultivate the land.

APPENDIX No. 2.

VILLA GARDENING.

(By Marian W. Thompson, First Year Student.)

When making a villa garden, it is necessary to recognise the limitations of that particular branch of horticultural work, and carry out operations accordingly.

There are no natural features, such as abound in our mountainous districts, to assist us in our efforts to make home surroundings beautiful. The monotonous stretch of macadamized street surface, and a motley collection of inartistic house frontages, though, doubtless, of great utility from the contractor's point of view, do not afford much scope for the formation of beautiful gardens.

Space is limited, and we are restricted to planting certain varieties of shrubs and flowers, which must be hardy enough to resist the debilitating effects of our changeable climate.

Though we may admire delicate ferns and hothouse plants, with their exquisite flowers, we must be content to grow them in more congenial surroundings than in an ordinary suburban garden.

In order to make a garden that will ultimately become a source of delight, combined with a degree of common-sense utility (which is quite possible, in spite of limitations), one must be prepared to do an amount of merely preparatory work, which, to the uninitiated, seems almost superfluous.

Such operations as grading and draining, and even trenching and manuring, throughout the entire area, which are necessary to success, seem quite too formidable to the ordinary suburban householder, who does not consider the making of a mere villa garden a serious matter. His usual proceeding is to simply dig up the surface, plant all the favorite flowers of the family, without regard to suitability of soil or surroundings, water them occasionally, and leave the climate to do the rest, which it *does thoroughly*.

One reason, perhaps, why so many suburban gardens are a source of dissatisfaction to their owners is the want of accurate knowledge of the main essentials of making a garden, which people exclusively town-bred do not usually possess in the same instinctive degree as those who have passed their lives in rural districts.

The initial work of preparation is comparatively heavy, and takes much longer when a garden is already established than on an area where a house is first built.

HOEING YOUNG CROPS.

The actual labour consists of—

I. Cleaning the area of all rubbish and burning it, and making a rough design.
II. Grading, trenching, and manuring, which can be made one operation.
III. Taking precise levels (all levels from highest points).
IV. Allotting land between the points.
V. Laying the drains where required.
VI. Making all necessary paths—main approach, side entrance, &c.

After these rules are carried out, the final design may be decided, after consideration of aspect, size of garden, position, and architecture of house.

No matter what design is ultimately adopted, the foundation work should be the same in nearly all cases, with this exception that the quantity of manure will vary according to the quality of the soil.

The best season to begin the preparatory work is early in autumn, in order to have manure thoroughly incorporated with the soil, and settled down in readiness for planting as much as possible during winter and early spring.

It is necessary to grade and trench the entire area, in order to make the soil of a uniform depth; trenching deepens the soil, and lasts practically for all time. The site for a villa is not determined by the horticultural properties of the soil, and in making a garden all deficiencies in that respect must be remedied by careful preparation.

Grading will equalize the soil so that scarcity of moisture and superabundance of heat in isolated portions of the garden may be done away with; in a garden composed of heaps and hollows the rain water would remain in puddles, become stagnant, and consequently sour the soil. Grading will facilitate the laying of drains, make all subsequent working operations easier to carry out, and add materially to the appearance of the garden when finished.

Manuring is generally required in suburban areas, to enrich and give body to the soil. The best soil for garden purposes is of a loamy character, deep, and friable. If not naturally of that description it can always be made up and improved—a close sour soil by the addition of lime and ashes, and heavy clay soil with sand, ashes, and lime. Thorough cultivation alone will improve any garden materially, but the general want in suburban areas, as elsewhere in Victoria, being humus, it follows that the addition of well-rotted stable manure or decayed vegetation, litter, &c., may all be worked in when trenching. (A general rule when cultivating is to allow twenty loads of manure to every acre.)

Air and water are as necessary to the development of plant as of animal life; and both air and water must circulate freely through the soil ; rain is fertilizing in its effects, but if it cannot pass freely through the soil the beneficial results will be lost to a very great extent.

Draining will only carry off excessive moisture, and not rob the land of what is required ; for, as land can only hold a certain amount of water, any excess will remain on top (to form a film excluding air) or run away.

Agricultural drain pipes are the best for this purpose, put in at a depth varying with the nature and form of the surface soil.

We should always endeavour to lay out a garden on a sensible plan, to allow of working with comfort and despatch, and place taps in such positions as to allow a hose to be uncoiled without injury to flower beds.

Though we may find it necessary to overhaul every corner in future seasonable work, it does not follow that a large number of paths are required. They are expensive to make and maintain and are not necessary for effect or as a means of reaching all parts of the garden. Curved paths are more attractive in appearance, and give the effect, when curves correspond in length and width, of greater space than an uncompromising straight line from entrace to house. An inexpensive path may be made of brick-bats, lime, rubble, and sand, which, if damped thoroughly before rolling, will make a hard, smooth durable path. The most effective flower-garden paths are of turf. Tar-paved walks throw the heat of the sun into the soil and dry it out.

When the heavy work is done, and the soil of a nice even tilth, the final design may be carried out. Villa gardens vary in size and shape, but there are several points that are helpful in all cases.

I. Any design should be in accordance with house, pocket, and comfort.

II. Mathematical designs and those characteristic of easy negligence should not be used in the same garden, as they produce an inartistic effect.

III. The relationship of house to garden and *vice versâ* must be observed.

IV. When planting a bed to be viewed from all sides, place the highest-growing plants in the centre, and graduate the others according to size.

V. Put strongest-growing plants in the coldest and wettest portion, and give open and best soils to those plants having the shortest life. Aspect is always of importance in the design; the house facing the south

protects the garden to a certain extent, and breaks the force of north winds, which are ruinous in their effects during summer. A southern aspect is favorable for summer, but coldest in winter. Summer conditions are the most trying, and in a garden having a northern aspect one should clothe the place as much as possible with high-growing hardy shrubs and creepers on the fence nearest the north ; always have a good background to shade the garden in summer.

VI. Avoid narrow borders, straight lines, fixed patterns. Grass borders should be 16 inches or 18 inches in width in order to retain moisture and for convenience when mowing. All narrow borders dry out and look mean.

If we desire our garden, when finished, to reflect nature in beauty and completeness, we must have sympathy with the plants we cultivate. To keep them healthy and in a state of active growth, we must give them the nourishment they require during the different seasons. We must not starve them during the early stage of their existence.

It is unreasonable to expect plants that have been neglected to build up a healthy organization and perfect flower and seed.

Individual tastes generally determine what shall be planted, but, to be successful in planting a garden, an accurate knowledge of various plants should be acquired, a knowledge of form, size, texture, period of flowering, and length of life.

Before planting, the plants to be employed should be carefully arranged. Two deciduous plants should not be put together, nor many of the same colour, size, or habit.

In making a lawn it should be put in wider than wanted, otherwise in summer it will fret, and in winter wash away. If made of buffalo grass, the best time for planting is from November to February. This grass may also be planted in winter and spring. To provide a quick-growing lawn of a vivid green, put in the young roots just starting in small pieces. Should large pieces of old buffalo be used the resulting growth will be weak. Allow the grass to grow irregularly over the edge and trim afterwards.

A plot of ground should be provided apart from the show garden to start seeds and cuttings, and a supply of pot plants kept on hand to fill up vacant places. Bulbs are also useful for this purpose.

It is impossible to give a long list of flowers suitable for villa gardens in this essay, but such established favorites as Camellias, or good varieties of Roses or Azaleas are suitable for the centre of flower plots, while Carnations, Bouvardias, and Heaths may blend with low-growing flowers such as Verbenas, Pansies, and

Petunias. For backgrounds and extensive borders Cannas, Dahlias, Helianthus, Cosmos, and Variegated Maize are most suitable, being hardy summer flowers.

Once established, a villa garden, in our trying climate, needs systematic attention. Each autumn it should be thoroughly overhauled. Recognise what is not necessary, take out exhausted and dead plants, and expose as large a surface as possible to the air. Stock should be raised or procured twice yearly, in order to provide for all seasons.

Everything should be done to deepen the soil. The right time for deep digging is in autumn or winter.

The lawns will require top-dressing in autumn, and mowing and weeding at intervals. Pruning will be necessary every year. The time is, in general, after the period of flowering is past. Shrubs should never be left for so long a period as to require harsh treatment. Pruning is necessary to keep plants within bounds, to quicken and rejuvenate the roots, to promote fine foliage and flower in abundance, to provide healthy and attractive form, and to let a proper degree of light into the soil. Prune hardwooded things in general when temperature is falling, and soft-wooded when the rigors of winter are past.

LEVELLING AND GRADING LAND.

APPENDIX No. 3.

LEMON CULTURE.

(*By Florence Jacomb and Marian W. Thompson, First Year Students.*)

In selecting a site for the purpose of cultivating lemons in Victoria, one should be guided, in making a choice, by several definite properties of climate and soil, which are the two most important considerations, and should be in accordance with the special requirements of that particular fruit.

The climate in some parts of Victoria is exceedingly well adapted for growing the fruits that are brought to perfection in the south of Spain and France, and the low-lying valleys of Italy.

A warm climate and permanent supply of moisture are necessary. It is almost impossible to state the exact annual rainfall required, as conditions vary considerably in different parts of the colony. Choose a locality where the soil does not dry out, and where the spring rainfall will provide for summer exigencies.

The native home of the lemon is under the protection of other trees, therefore an extremely exposed situation would not be suitable. In summer the continuous hot sun would cause evaporation of moisture when most required, and cold winds in winter would have a perishing effect on all except the very hardiest trees.

The actual position of the orchard may be determined, partly, by the natural features of the country; the great desideratum being an area that is permanently enriched by surrounding influences, not impoverished by them.

Being an evergreen, continuously growing in a more or less active degree, the lemon makes heavy demands on the soil, which should be deep and of a permanent character.

A permanent soil consists of deep, turfy, friable loam over broken stone and gravel. The nature of the substratum is of importance. A dry heavy subsoil is bad, and wet and sour soils are to be avoided, as the roots are subject to disease. A deep comparatively poor soil is better than a rich shallow soil. The former can be improved by cultivation and the addition of manure, but a shallow soil is rich for a brief season only.

Gentle undulating surfaces and sloping country providing natural drainage are the best. Sloping country will reduce the labour of preparation considerably, by making grading easier, and facilitating the laying of drains if required.

A southern or sheltering aspect and fairly high elevation, 200 to 1,000 feet, should be selected. All lowland countries are too

dry for citrus, without watering in summer, and more subject to frosts, unless on the sea-board, than high rolling lands, where atmospheric influences are more favorable.

Heavily-timbered country is generally good. Scrubby land is generally sour and poor. It is better to choose comparatively expensive land where there is permanent soil and moisture, provided it is within reasonable distance of a market, than to purchase cheap land which would require heavy working expenses in order to produce good crops of fruit.

Preparation of soil will vary according to area. Should forest land be chosen, all trees and roots must be grubbed out and burned on the ground. Plough and roughly grade, putting the worst soil at the bottom, then grade it precisely, plough again, clean off roots and rubbish, and then double-plough (have at least 10 inches of free soil), and harrow to obtain good tilth. The soil should be prepared in early autumn, and the opportunity should be taken to get rid of all impurities in the form of insects and fungi. Manure is not required in rich deep soil for young trees, but the addition of lime at this early stage, to sweeten the soil and dissipate any sour acids, would be of value.

Grading will equalize and improve the soil. In making an orchard it is necessary to grade and drain it in order to get good results. Heaps and hollows must be graded out. A portion of ungraded land in orchard holds an excessive amount of moisture, fouls the soil in winter, and makes it in summer unnaturally hard.

An area favoured with natural drainage can sometimes be obtained, but, if not, draining will be included in the preparation of the land. A system of drainage that will act perennially is required. Should the orchard be covered with water in winter, the soil will become foul and stifled for want of air. The object of getting rid of this excessive moisture is to obtain air, sweetness, and the proper degree of heat in the soil. After the preparation, the stations for trees should be pegged out at a distance of from 18 to 24 feet apart: regular planting secures an uninterrupted flow of air and light, and simplifies cultivation. The square system of planting is the best, it admits of ploughing eight different ways, and allows room for the development of each particular tree.

Maintaining the fertility of the soil can only be done by systematic and persistent cultivation, and by the addition of manure. We can maintain the fertility of the orchard by growing crops of legumes, and ploughing them in before they are perfectly matured, thus adding nitrogen and humus in an inexpensive manner.

In this country the ground is more impoverished if left open than when cropped; as the climatic influences are more deteriorating in their effects than are crops, and waste more of the food

supplies. We may grow vegetables in the orchard while the trees are young, to cover and shade the soil. All vegetables thrive best in generous deep soil, such as is required for cultivating the lemon. They could be grown alternately with the crop of legumes, until the trees attain maturity.

Stocks and Varieties.—The three best varieties for Victorian growers are the Variegated, Lisbon, and Villa Franca, the last-named being a very generous summer cropper, but requires more generous soil than the Lisbon. At the present time, stocks are being done away with throughout the colony and New South Wales, and layers are being used instead; but though these fruit earlier, and do very well in generous soils, they are not so hardy or long lived as budded trees on seedling stocks. Stocks worked on sweet orange, or own stock, may be used, providing they are healthy, with good circular root system. Budded stocks are best. There is greater vitality in any budded stock than in grafted, as the bud is younger and fresher than the piece of hardened wood which forms a graft.

Forming young trees.—The lemon is an umbrageous shrub, and should be trained as a bush, not a tree, its branches should come from near the ground. If trained as a tree, it will not be so profitable as when trained as a bush. The first necessity is a crop of wood ; very few heavy branches are required on a citrus tree, and they should be horizontal rather than upright, and trained to make a useful framework.

In forming the young lemon tree, if any of the young shoots are not in the right place, they should be taken off. This will cause the sap to be thrown down, and force shoots to grow in other places. It is not necessary to cut off the young shoots, as they may be removed by the fingers.

We prune the young lemon tree to distribute the wood, and get the tree into shape. All useless wood should be got rid of, and the weakly shoots cut out. The lemon tree grows twice a year. The heavy pruning in established trees is late in this colony, as it is on the extreme belt of citrus country. The lemon is branch-pruned, and it does not want too many branches; so it is best to cut away all the thin branches, and only to leave those that are strong enough, and are in the best position. The tree must not have direct exposure, nor must it be smothered; the weak wood should be cut out, the other thinned, and the shoots that have borne fruit cut back. The pruning of lemon trees extends over nearly all the year, the heavier pruning being done in August or September. If it were done earlier, while the weather was still cold, the wood would be hardened by exposure to the cold, and would not break and send out shoots, and the bark would die.

The thinning of the light wood in established trees can be done when they are carrying fruit. The pruning can also be done at the time of gathering the crop, the shoot being cut off with the fruit. This is the most economical way. In pruning, the whole of the shoot should be cut out. The points of the shoots should never be cut off, as that would cause the tree to grow too thick in the head, and promote growth where it is not wanted.

If it is necessary to take out intermediate branches, it should be done after the tree has borne fruit, when the heavy pruning is being done, and immediately after the crop has been gathered, as then there is no waste of energy, the sap being more or less at rest.

The light thinning out is done after the tree has borne its summer crop, and the heavier pruning after the winter crop. Excellent crops can be obtained from lemon trees without pruning, but only when they have plenty of water and exceptionally good soil. But if the tree suffers from want of water, it will require pruning, as it will make too much weak wood.

In the early winter, the soil round lemon trees should be protected by the lower branches. If a tree suffers from blight, it should be stripped of leaves and all light wood, leaving no branches less than an inch in diameter, then it should be covered with a paste made of 10 lbs. of clay, 1 lb. of sulphate of copper, and enough water to make it into a stiff paste. A canvas hood should be placed over the tree to protect the wood from the sun; a trench should be dug at the drip, as this is where the foraging roots are, then the roots should be cut, and manure and new soil given. This should be done in the winter. Lemon-growing in this colony may be considered one of the most profitable of the fruit-growing industries, as 2 acres of trees, from four to six years old, grown under favorable conditions, may be expected to give a return of £100 to £120 a year. Before that age they cannot be considered established trees, and of course the profits are less.

Lemons carry very well and are particularly adapted for export. They find a ready sale, either in the local or European markets. The expense of cultivating the orchard may be reduced by growing and marketing vegetable crops for the first four years. After that period the whole of the area will be required for the trees, and, in the summer months, the soil should be protected by mulch of well-rotted stable manure, or any litter that may be obtained conveniently and cheaply. The mulch should be put on in October, and removed in March. After the orchard area is prepared, and trees planted, the work is not heavy. The tree is not difficult to prune, and the seasonable work of a lemon orchard may be considered fairly light and easier to manage than orchards composed of deciduous fruit trees.

PREPARING GROUND FOR VEGETABLES.

APPENDIX No. 4.

AN EXAMINATION PAPER.

(By G. J. Wilmoth, First Year Student.)

State (1) the bad and (2) the good influences of climate on soil.—1. Hot dry winds have a very bad effect on soil. The heat dries it, and wind carries away food-stuffs in the dust. Soils in damp cold climates are apt to become sour unless the cold is severe enough to cleanse them, which it is not here. Sudden changes are bad for vegetation. The sun draws up moisture, and bakes soil in places quite hard, so that roots cannot move and are pinched and wounded. 2. Warm moist climate has very good effect, as it means plenty of growth and a long growing season. Anything, given ordinary soil, will grow under these conditions. Frost is good for soil, as it breaks it up, and thus the food-stuffs are more easily got at.

State direct advantages from cultivating soil.—It makes food-stuffs available for plants by keeping the surface open, allows air and moisture to penetrate, breaks up capillaries in ground through which the sun draws up moisture, and thus keeps the ground more moist. By keeping ground friable, roots can move, and, in summer, surface cultivation makes a kind of mulch. The more the land is cultivated the less manure is necessary, as cultivation frees what food-stuffs there are.

What natural features should guide your selection of orchard and garden land?—Situation—whether near market, whether water and manure are available or easy to get, whether natural drainage or sufficient slope to drain with facility, not too great incline that water will wash ground to speak of; whether soil be deep (better to have deep and comparatively poor soil than good and shallow) and habitually moist. Also, the trees one wishes to grow would determine what kind of soil one wanted, or *vice versâ*. A southern slope is generally best in Victoria; the northern aspect is too hot in summer. Good natural soil is very much to be desired, as is also a spot sheltered from severe wind.

What means would you employ to free soil of injurious insects and fungi?—The ground should be cleared of all rubbish, and this should be burnt. Leave ground open some time before planting; light and air are great enemies to all kinds of fungi and blight. A light dressing of lime might be used if the ground is very dirty.

What are the good effects of drainage?—Drainage conserves moisture in summer and keeps soil drier in winter; it means that what water there is in the soil is kept moving, and it is when

water is moving that it collects food and carries it to the plant. There being no surplus water lying about in winter, the ground is sweeter, more friable and acceptable to the roots of plants.

What determines the amount, frequency, and kind of manure necessary to any soil?—The kind of manure necessary depends on the nature of the soil. Light sandy soil needs heavy vegetable or farm-yard manure; close, clayey and damp soil wants manure that will open it and make it lighter. As a rule, one dressing a year is necessary, but the quantity contained in each dressing depends on the needs of the tree, the poverty or richness of the soil, and the quantity of water available (manure keeps the ground moister, so, the drier the soil, naturally the more manure it will need).

Which twelve fruits are most profitable to Victorian growers?—Pear, peach, apricot, plum, apple, lemon, raspberry, gooseberry, strawberry, grape, passion fruit, currant.

What point should guide you in selecting young trees?—The most imperative thing is a good root system—not too many fibrous roots, and some good leading ones. They should be evenly placed round the tree, as this means even growth in the head. The trunk should be smooth and straight, not too long—the shorter the better in a climate such as ours—and three, four, or five healthy branches at the head. We should regulate our choice by the situation in which the trees are to be planted—climate, soil, and aspect, as well as the amount of water and cultivation we can give them, being taken into consideration in selecting the variety. It is preferable to get trees that have been out of the ground as short a time as possible. As a general rule, budded trees are best; but if the situation is very good, and the soil very generous, pears that have been grafted—and even apricots—would be better than budded specimens. Another thing is the best stock. In hard or wet cold situations the stock should be thrifty and vigorous; strong-growing stocks not being used in very generous situations.

State the conditions under which (1) budded and (2) grafted trees should be employed.—Budded trees should always be used in any but the most generous soils and conditions, as the grafting has a dwarfing effect, and means poor growth, with that exception. Pears may be grafted, unless in hard situations, as this is such a vigorous, strong-growing tree. With short-growing seasons, wet damp soils in winter, dry situations in summer, or excessive heat or wind, budded trees should be used without exception.

Explain the advantages of design and equal vigour in fruit trees.—Equal size and vigour means equal growth and equal fruiting, which, in its turn, means easier management of trees and gathering of fruit. It also means less strain on the tree if it bears equally. The design allows light and air to reach every

part of the tree ; hence all the wood ripens and keeps fruitful. A thick head means bare, barren branches in the centre, and a narrow band of fruiting wood round the outside of the tree. A well-designed tree enjoys better health, fruits regularly, and lasts longer than an irregular specimen. Trees designed to be low and broad at the base shelter their own roots, and thus can stand the summer heat better.

What determines the size, shape, and internal structure of a tree ?—Various things, such as natural local conditions, cultivation, pruning, and variety of tree. The pruning for the first years builds up a good, strong, shapely head, more or less vigorous, according to variety of tree, stock, and whether budded or grafted. The deeper and better the soil and the more moisture it gets, the more vigorous the growth, and, of course, the pruning accords with the vigour of the tree—less vigorous, fewer branches and less work being allowed the tree. A tree with low horizontal branches—pyramid or dome shape—is good here, as it shelters its own roots and its fruit, and this is a great advantage in a warm climate. The internal structure depends almost entirely on the strength of wood required for fruiting.

What is the object of pruning during the first few years ?—The object of pruning during the first fewyears is to train the tree to a good shape, the branches even in quality and evenly distributed, not so close as to prevent light and air reaching every part of the tree, and not too many of them, to make each one small and weak—four or five small branches are generally enough. The pruning at this time is all for wood, as if the young tree were allowed to fruit—even if inclined to do so—the wood would be hardened, and the tree weakened, and short-lived. The first object to be attained at this stage is a strong, shapely tree, with a good root system, on which the only strain should be that of producing a strong, shapely head.

How would you preserve a full supply of fruiting wood on the lower portions of established trees?—Keep the top light, and throw back the sap by free cutting of top, letting in light at the same time. This will flood the lower branches, and by doing so every season, the entire tree may be kept fruitful. All weak and useless wood must be cut away every year, to induce strong buds to break.

Give some reasons for barrenness or irregular fruiting.—May be growing too strong to fruit, or may not be strong enough ; may be through starvation, or want of water (which means the same thing). The trees may be seedlings, and seedlings are always uncertain in fruiting. The fruit may not set, the flowers may not be pollenated ; may be due to our soil, the result of imperfect cultivating. This is one of the most common causes of unfruitfulness.

Name and give age of fruiting wood in apple, peach, and apricot.—Apple bears on wood two seasons old (except when wood made previous season has been spurred in autumn) and then on the same spurs two, three, or four years, according to strength of wood. Apples bear on spurs only, either natural or artificial. Peach bears on natural shoots and natural spurs of last season's growth only. Apricot bears on natural shoots and spurs, and of last season's growth, and then on the same spurs for two, three, or four years, as the wood is strong or otherwise, and on artificial spurs, so long as they are strong and healthy.

What enables one to decide on the most favorable season for pruning various shrubs ?—It depends partly on the situation and climate. In cold, exposed places it is left later than under generous conditions and warmer situations. Pruning is always done just after the time of flowering or of greatest beauty (if not flowering shrubs). It should not be done early enough to encourage growths that will be cut by late frosts. In case of shrubs pruned in winter, these will be hard-wooded. Soft-wooded shrubs are almost invariably pruned in spring ; these should be pruned early enough for buds to get a good start before the hot weather sets in. Also it depends upon the vigour of plant and quantity of flowers. If too strong to flower well, late pruning will generally throw it into flower, on account of the check received.

What governs the arrangement of plants in a villa garden ?—Soil, aspect, water, and cultivation available, and plants at one's disposal. Tallest shrubs are placed at highest points, and never in front of smaller plants. The hardier plants should be placed in the poorest and most exposed situations, and *vice versâ*. One always takes one's point of view from the main entrance, and regulates the planting accordingly. Always plant so that the effect increases the apparent size of the area at one's command. Plants that are similar should never be placed side by side, and they should always be so arranged as that there is never a bare part here and one looking very full there. Masses always give better effect than plants placed singly.

Arrange these subjects in the order in which they should be taken on a new garden area : Trenching, grading, draining, designing, manuring, cleaning.—Clearing, grading, trenching and manuring, draining, designing.

Why do cuttings strike more readily in pots than in the open ground ?—They get more moist heat than in the open—the heat of the pot draws the sap down, and encourages rooting. The soil used—sand, sandy or peaty loam—is sweeter and more favorable than general garden soil. Some cuttings touch the bottom of the pot ; this, as said before, draws the sap down ; and it is for the same reason that the cuttings nearest the edge of the pot root more readily than those nearest the centre. Also, the cuttings are more sheltered, and not subjected to extremes of temperature.

Why do we water trees and plants before transplanting them ?—The water keeps the air away from the roots when they are being moved—they have also benefited by the nourishment, but the chief reason is that the damp soil kept round the plant excludes the air, and it prevents injury to the roots. It also makes it so much easier to take up a ball of earth with the plant.

Which are the most favorable seasons for overhauling beds and borders and carrying out reforms in the soil ?—Spring and autumn, the latter in particular ; all big alterations and reform should be carried out in the autumn, and the plants should be manured when most inactive, generally late autumn and winter. Mulching should be done in late spring or early autumn, before the ground gets dry, and after it has quite recovered from low temperature—mulching then has the effect of vapour bath for roots, and prevents growth receiving check by ground drying out.

What natural features enable one to supply the right class of manure to various plants ?—It depends on the nature of the soil and of the plant. Gross feeders will take ranker manure than others. Some can only stand manure that is thoroughly spent. These are in the great majority. If the plant be growing too vigorously to flower and fruit, it needs little or no dressing ; a weakly tree needs plenty of good well-spent manure. Some plants will stand more than others, and, apart from the general fact that the shorter-lived the plant the more it needs, this must be decided by experience. The heavier the soil, the more opening the manure used must be ; ashes, lime, &c., being splendid for heavy soil, but lime must be used with great care. Heavy soil, as a rule, needs working as much as manure, but light soil needs any quantity of manure. The drier the soil the more manure it requires—manure conserves the moisture so much in summer. Also, the drier the soil, the more waste from the elements and the more food to be replaced. Again on a slope, water carries much food away, and all this must be made up to the plants. Manure should never be dug in near the trunk, it encourages small roots, but just outside the roots, so that they may be encouraged to move. Practically, the best all-round manure is well-spent stable manure.

What necessary property is most rare in the dry and warm Victorian soils ?—Humus.

Which are the most favorable seasons for raising young stock in the open air ?—For apple root grafts, late winter ; for cuttings, early winter and late autumn ; for seeds, late summer, autumn, and spring. Class of soil: Sandy loam, over ironstone or limestone, or with gravel beneath, fairly moist naturally, as irrigation does not at all improve grapes—rather spoils them, in fact, making them too watery. Site: On slight slope, not exposed to wind, as this hardens the skin, not higher than 1,000 feet above sea-level. Class of wood for cuttings : Take, if possible, with small foot, as

the buds at base make roots quicker than those higher up. Select wood of previous season, fairly strong, but not late or water growth. Heavier and colder soil, more slanting, plant the cutting. Plant with only two buds above ground.

When are all kinds of plants most liable to attacks from insects and disease?—Most liable to attack when not growing freely. Therefore, poor growth and checks should be avoided. Different insects are worst at different times—red spider in dry warm weather, aphis in warm moist weather, scale at any time—with pear slug, borer and codlin moth; health of tree makes little difference. Pests are generally most active in spring, and best time for treatment is after pruning, and when the tree starts to grow in spring and early summer.

What kind of vegetables and flowers are able to thrive in rank unfermented manure?—Very few. Cabbage, cauliflower, gourds, certain root crops and a few annuals, only exceedingly quick-growing things; all quick-growing plants will thrive with any quantity of fermented manure, but few can stand it unfermented.

State briefly the essentials to success in vegetable culture.—Good rich soil, water, good drainage, cultivation, quick growth with no check whatever, market easily available.

Name six vegetables profitable on a small area, and seasons at which they are marketable.—Asparagus, in the spring and summer; highest value in spring. Tomato: Best price when very early or very late, in season summer and autumn: tree tomato in spring as well. Cabbage: Winter and autumn. Cauliflower: Summer and early winter. Brussels sprouts: Same as cabbage. Pea: Early summer.

State seasons at which different classes of pruning are carried out in citrus trees.—The following answer is taken from the examination paper of Mrs. J. McWilliam:—"All heavy pruning of citrus trees should be done in winter, after the removal of crop, which generally can be gathered at midwinter. If there has been no winter crop, prune as soon as cold weather sets in. Also cut away the tiny shoot that has actually borne the fruit; never tip citrus. These tiny shoots are best removed by cutting the fruit instead of pulling it off when gathering crop. Young citrus do not require much pruning, as they will be replaced by the strong shoots which come away at base, and afterwards form permanent tree, then original growth may be cut away. During spring citrus trees require thinning and spacing to let in air and light, about 18 inches apart for shoots. If trees are dormant and making no growth, cut off all twigs and shoots, and prune hard, then protect with canvas; shield from sun. On the top will do, but, better still, if canvas hood reaches ground; then spray and vapour caused thereby promotes growth."

A LESSON IN DESIGNING FRUIT TREES.

APPENDIX No. 5.

SELECT LIST OF TWELVE LEADING FRUITS SUITABLE FOR LOCAL AND EXPORT MARKETS.

Twelve Good Pears.

1. Williams' Bon Chrêtien ; February.
2. Beurré Capiaumont ; February and March.
3. Louise Bonne de Jersey ; March.
4. St. Michael Archangel ; April.
5. Beurre Clairgeau ; May and June.
6. Doyenne du Comice ; June and July.
7. Vicar of Winkfield ; June and July.
8. Eyewood ; June to August.
9. Josephine de Malines ; July and August.
10. Winter Nelis ; July and August.
11. Easter Beurré ; August and September.
12. L'Inconnue ; August to October.

Twelve Good Plums.

1. Early Orleans ; December.
2. De Montfort ; December and January.
3. Prince Englebert ; January.
4. October Gage ; January.
5. Diamond ; January.
6. Washington ; January.
7. Kirk's ; February.
8. Angelina Burdett ; February.
9. Yellow Magnum Bonum ; February.
10. Fellenberg ; February and March.
11. Pond's Seedling ; March.
12. Ickworth's Imperatrice ; March.

Six Prune Plums.

1. Prince Englebert.
2. De Montfort.
3. Angelina Burdett.
4. Fellenberg.
5. French Prune.
6. Diamond.

Twelve Good Apples.

1. Jonathan ; March.
2. Rome Beauty ; May to July.
3. London Pippin ; April to June.

4. Prince Bismarck ; March and April.
5. Munro's Favorite ; June to August.
6. Esopus Spitzenberg ; June to August.
7. Rymer ; August to October.
8. Reinette de Canada ; March to May.
9. Stone Pippin ; August to November.
10. Scarlet Nonpareil ; July to October.
11. Cleopatra ; August to October.
12. Shepherd's Perfection ; May and June.

Six Good Apricots.

In order of Ripening.

1. Oullin's Early.
2. Kaisha.
3. Alsace.*
4. Hemskirke.*
5. Mansfield Seedling.
6. Moorpark.*

Four Almonds.

1. Paper Shell.
2. Brande's Jordan.
3. I.X.L.
4. Nonpareil.

Twelve Good Peaches.

Arranged in order of Ripening.

1. Alexander's Early.
2. Briggs' Red May.
3. Downing.
4. Early Rivers.
5. Hales' Early.
6. Royal George.
7. Duke of Edinburgh.
8. Merchant Campbell.
9. Lady Palmerston.
10. Salway (or Mixon Free).
11. Susquehanna.
12. Whatmough's March.

Six Gooseberries.

1. Billy Dean (red)
2. Crown Bob (red).
3. Roaring Lion (red).
4. Leveller (yellow).
5. Waterloo (white).
6. Lord Crewe (green).

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* Suitable for drying and canning.

Six Raspberries

1. Belle de Fontenay.
2. Rivers' Monthly.
3. Fastolf.
4. Wandin.
5. Semper Fidelis.
6. Northumberland Fillbasket.

Six Strawberries.

1. Edith Christy.
2. La Marguerite.
3. A. F. Barron.
4. Laxton's Monarch.
5. Latest of All.
6. Trollope's Victoria.

Six Currants.

1. Carter's Black Champion.
2. Lee's Prolific (black).
3. White Imperial.
4. White Dutch.
5. La Versaillaise (red).
6. La Hâtive (red).

Twelve Cherries.

Arranged in order of Ripening

1. Early Purple Guigne.
2. Bigarreau Twyford.
3. „ Rockport.
4. Knight's Early Black.
5. White Heart.
6. Bedford Prolific.
7. Black Tartarian.
8. May Duke.
9. Bigarreau Napoleon.
10. „ de Hollande.
11. Florence.
12. St. Margaret's.

Three Lemons.

1. Villa Franca (summer fruiting).
2. Lisbon.
3. Lisbon Variegated.

THE DOOKIE AGRICULTURAL COLLEGE.—NORTH-EASTERN DISTRICT.

REPORT BY Mr. HUGH PYE, PRINCIPAL, AGRICULTURAL COLLEGE, DOOKIE, ON THE EXPERIMENTAL WORK OF THE COLLEGE FOR 1899–1900.

EXPERIMENTAL WORK, 1899–1900.

Those who have done much experimental work quickly come to the conclusion that the yields of grain are, as a rule, proportional to the thoroughness of the methods of cultivation adopted.

Thus, where the experiments are small and are thoroughly within the grasp of the individual, the relative yields are high, —in fact, exceedingly high sometimes—and, to some extent, are misleading to the farmer, who will not see in the experiment the principle which gives the warrant for carrying out larger experiments. Perhaps, too, the sanguine experimenter impresses the novice to such an extent that it is thought that all that has to be done is to buy the much-talked-of variety of grain, drill it in with a certain amount of manure, and, at the harvest, fill from ten to fifteen bags of wheat to the acre. Now, the more experienced farmer would not be so sanguine, although he may appreciate the spirit of the experiment. He would not rely so much on the variety of the wheat as on the amount of labour involved, the method of directing it, and, lastly, what the total cost compared with the probable net return will be. Then we have the man who owns land, and who thinks that there is nothing under the sun in the farming line that he does not understand. He does not take an agricultural paper, and so keep up to date; he tells you that manures exhaust the land; but, in the same breath, when you tell him that five to six bags of wheat per acre were taken off an old cultivation paddock, he says—"Oh, yes! but you used manures"; yet, with this convincing fact before him, he still may not appreciate it, but remain true to his ignorance or want of faith in his own judgment. There is, again, the farmer who tries the experiment and fails, although he has faith in it. There must be some cause for this failure if the experiment has proved a success elsewhere. Where does the failure lie? That is the next question, and here the farmer is often lost; and here it is that the good work of the experimental stations, that are likely to be established over our fertile country, will come to his rescue; and, as time goes on, no doubt, the system will be extended to the carrying out of feeding experiments with stock, both in respect to the production of dairy produce and of meat.

I am convinced that the object lessons seen at an experimental station will do more towards carrying conviction to the farmer as to the most suitable methods to be adopted for his conditions than anything else, and they will afford a theme for discussion at the meetings of the district agricultural societies which will be far more beneficial to the farming community than, as at present, devoting so much time to drawing up and altering the annual prize list.

Some wheat-growers put too much faith in the variety of wheat sown, and not sufficient faith in thorough cultivation. Though, no doubt, certain varieties may be more suitable than others for certain districts, still the fact remains that the yields at harvest time, other conditions being equal, are proportional to the thoroughness of the methods of cultivation adopted; for, although unforeseen troubles may arise, such as late frosts, boisterous winds, caterpillars, &c., still, if we extend our observations over a series of seasons, the principle of the thoroughness of cultivation stands paramount.

The past season has been a very trying one to most crops, consequently it will be found that the average yields do not come up to expectations. Notwithstanding this, the grain is of a superior quality, which is more surprising when we note that the rainfall during the last half-year is 3·78 inches less than the corresponding half-year of 1898.

The weight per bushel of about fifty varieties stripped this season varied from 61½ lbs. to 67 lbs. The only wheat that weighed less than 63 lbs. per bushel was Fultz, which weighed 61½ lbs. This wheat is a favourite with some farmers in North America, but is unsuitable for this climate. As the Purple Straws have more than a passing interest to the farmers of the northern areas, it will be interesting to compare the weight per bushel of this grain with that of some of the more important wheats of other groups. The average weight per bushel direct from the winnower of eight varieties of Purple Straw was 65 lbs. ; that of the Lammas wheats was 66 lbs. per bushel, and that of the Tuscan group 65 lbs. The Steinwedel group, including Steinwedel, Pride of Barossa, and Sullivan's Early Prolific, averaged 66⅓ lbs. The Allora Spring group averaged 65 lbs., the Ward's Prolific group 65lbs., and the Essex group, including Frampton and White Essex only, 65½ lbs.

It would be interesting to the wheat-growing world if the weight per bushel of wheat and other cereals was recorded every year at all the principal agricultural centres, as this, with other data, would most likely be of considerable value.

The margin of profit made in the growing and handling of wheat is often so fine that the producer and buyer are every day coming

more into conflict. The wheat buyer is becoming more exacting from the fact that, owing to the keen competition in the English markets, only the best wheats, or those up to a standard weight per bushel, can be profitably dealt with. In Britain and other places where the country is more or less dependent on its supplies of wheat from outside sources, the miller finds it essential to have some standard of quality fixed, in order that the supply of a certain grade of flour can be kept up, since, owing to the variations in the seasons and the difference in quality of the grain from the different grain-supplying countries, the art of blending the grain for flour-making purposes is every day being more highly developed, and more rigorously put into practice. Thus the wheat-grower becomes practically affected, especially one whose farm is in a district subject to many variations of temperature, and to a fluctuating rainfall. The question which then arises is—"What are the best methods to be adopted in the cultivation of wheat under all conditions of climate and soil?"—a question that can only be answered satisfactorily after systematic experiments have been carried out.

In reference to the effects of manures in the production of grain, there is still scope for much experiment; and it is most satisfactory to notice that the Agricultural Department has taken up the initial steps with energy, and in a way that is likely to increase the interest of the grain growers in their occupation. There are some misconceptions that a good number of farmers have yet to overcome in reference to the manuring of soils; but these are fast disappearing, owing to the research of scientific experimenters, often aided by the experience of thoughtful agriculturists.

In the past I have pointed out that fields manured with phosphatic manures invariably gave good returns in the Northern districts, and that light dressings were more economical to use than heavy dressings; but I am not prepared to state that exceedingly light dressings will give consistently the most economical returns when tried over large areas, unless the manure be in a highly concentrated form; for, owing to the want of moisture in the soil, the beneficial effects of the manure can scarcely be said to be felt, which is especially noticeable during dry seasons in late sown crops not sown on fallow ground.

The advantages of using concentrated manures or fertilizers may be summarized thus:—they are, as a rule, reliable; they have the plant food in an available and very soluble form; the percentage present is very constant and so facilitates the gauging of results; small quantities have far reaching effects; and freightage is comparatively less than that of ordinary manures.

The chief disadvantages of using concentrated manures are:—the apparently high cost, and the fact that the drills at present made will not distribute, evenly and consistently, very light

dressings without considerable caution being taken, which entails extra labour in watching the manure-runs. Damp weather usually affects them, making them difficult to distribute, owing to their absorption of moisture; extra labour must be used to mix with other matter to give bulk where drills are not expressly made for distributing light dressings of concentrated manure; also extra labour is required in screening the mixture, and extra cost is incurred in the purchase of screens.

The ordinary commercial fertilizers, such as the superphosphates made in this country, have their advantages and disadvantages; and at present I should be inclined to advocate their use by the general farmer and the wheat-grower, who have had little opportunity yet of manipulating seed-drills and in using artificial fertilizers.

The advantages of the less concentrated fertilizers lie in their apparent cheapness. Thus they foster an industry so essential to farmers, and bring the factor of competition with imported fertilizers into play, which tend to lower prices. The manures are as reliable as the certificates state; are in a form ready to be applied; give yields, on the whole, as good as those obtained from the use of concentrated manures, when applied in quantities of equal money values; do not require so much skill in applying, and are more readily obtained.

The disadvantages mainly lie in the extra freight; in the greater variation in quality from year to year, possibly from want of appreciation of detail; and in the difficulty of obtaining supplies of the raw material.

The quantity of manure a farmer may apply to the soil and get good financial returns from his crop, depends on the rainfall, on the methods of cultivation adopted, both in preparing the land for the seed and the after treatment, and on the selection of suitable varieties of seed. The more generously the land is treated, the better will it respond to the application of manures suitable to it. Manure may easily be wasted by applying heavy dressings, and even by applying lighter ones to badly prepared seed-beds, where, owing to the inefficient conservation of moisture through shallow and irregular ploughing, the crop is more subject to the variations of the weather. Unless a soil is in good heart, and not charged with weed seeds, it cannot be expected to give excellent returns. Manures can only give good results when the condition of the soil is such that those chemical and other changes so necessary for the existence of plants can go on in the soil without interruption. It cannot be expected that manuring is a talisman that will act when the methods of cultivation adopted are slovenly: in fact, it necessitates a more advanced system of cultivation, hence the introduction of the seed-drill and horse-hoe.

In a previous report I have pointed out that it takes much more moisture in poor soils to obtain a unit of plant tissue than in rich soils. However, in the latter soils, during the more favorable period of growth, there is a tendency to rankness, and, as soon as the first hot wind blows, or if there be a long spell of dry weather, the strain on the crop is very noticeable. To confine the stooling of the crop, it is better to give a heavier seeding, as there will not be so much strain on the individual plant.

In this district about three-quarters of a bushel of wheat per acre is sufficient in most cases. Where the seed is small, less is sometimes used. If the season has every indication of being a moist one, the seeding may be as low as half a bushel, if sown early, especially if the grain, like that of Nutcut, is small.

A number of varieties of wheat have been distributed during the autumn throughout different parts of Australia. As a rule, preference has been given by farmers to the larger-grained varieties, and especially those belonging to the Purple Straw type, owing to their excellent yielding properties; but, as these wheats do not succeed in all parts of Victoria, there has also been a demand for seed-wheat of other varieties.

Mr. Thomas Langdon M.L.A., kindly distributed some seed-wheats for trial to farmers living in the north-west parts of Victoria. These wheats were rather late in being sown, and in some instances, the plots being small, the sparrows spoiled the tests by destroying a good deal of the grain.

Mr. A. A. Dunn, of Lake Boga, considered Steer's Early Purple Straw the best of those he had. He said "that it is fairly early; its heads filled very well; it stood the weather well—best of the lot."

Mr. Job Weaver, of Boort, mentioned that, of the wheats he threshed from his small plots, Farmer's Friend came first, followed by Purple Straw Tuscan and Steer's Early Purple Straw.

Mr. Hugh Ennis, of Buckrabanyuie, placed Hudsonite and Hudson's Early Purple Straw the first on his list, but he could scarcely compare results, as the sparrows destroyed the four earliest varieties.

In most instances, the Purple Straw wheats that held the grain gave the best returns, as they were not so much affected by the severe wind storms that passed over the country as were the earlier varieties that are liable to shed their grain.

The Newmarket White oats, sown at the rate of half a bushel of seed to the acre, though giving a good-looking crop, did not ripen evenly, did not give as good a sample of grain, nor did they yield as well as the same variety, otherwise treated similarly, but sown at the rate of one bushel of seed per acre.

The Algerian oats grown on the farm, which were drilled in at the rate of one and a half bushels per acre, gave a yield of 50 bushels per acre in one field manured at the rate of 70 lbs. of ordinary superphosphate per acre, and 32 bushels per acre in a field manured with 80 lbs. of bonedust per acre, but sown later (May 9th to 13th). The latter was an excellent sample, being somewhat better than the former. For yielding well under almost all conditions of climate, the Algerian oat stands first among those grown here. The Calcutta oat, though not grown largely, yields well, but has defective straw, hence its unpopularity.

Barley does not appear to be grown to a great extent in this district, as it is thought that it is an unreliable crop; but, if it be put in early in good soil, it will almost invariably give satisfactory returns. If put in late, the results, as a rule, are not so satisfactory, especially if the dry season sets in early. Barley is a crop that must have plenty of plant food available, and thus it is not advisable to grow it in the poorer soils of such districts as this, unless the seed be sown early and the field is manured. Barley is much affected by manures, and their effect on the ripening of a crop is more pronounced than in the case of a wheat crop. No doubt, the harvesting of barley is open to more risks than the harvesting of wheat, owing to the effects of rain and wind, but, in these respects, this district is better off than others where barley is grown. If we take the average yield of the barley, oats, and wheat respectively, it will be found that the profits per acre here this season will be in favour of the barley, with oats second, and wheat last. However, there being a wider field for the disposing of the wheat, and it being more eminently suited for the country, it naturally follows that it takes the pride of place as a farm crop, but it need not shut out the other cereals from a season's cropping. It is becoming apparent that the number of aphides in the barley crops is increasing every year. The plants become of a sickly yellow, and produce grain of an inferior quality. Another serious pest that is rapidly making headway in the district is the sparrow. The yields of barley and of early wheats have been materially lessened by the depredations of this pest.

The late frosts this season were accountable for a good deal of damage, and a reduction in the yield of grain in this district, whilst the boisterous winds have occasioned further loss.

The barley crop in the lower-lying parts showed that the frost had affected it, but, notwithstanding, the yield was satisfactory, averaging 27 bushels per acre. It was noticeable in the frosted patches that occasional ears had odd grains on them well developed, and the straw also was strong and high. The sample of barley turned out was a good one, and should bring top prices in the market.

A small experimental crop of about 3 acres on a well-prepared piece of land that had during the previous season been under cow peas yielded at the rate of 40¼ bushels per acre. It had a seeding of 25 lbs. per acre and had a dressing of about 150 lbs. of bonedust per acre. Although the yield is a good one for this district, I am of opinion that it would have been better had the seeding been heavier. A small area of Hallett's Pedigree from seed supplied by the Honorable George Graham, the present Minister for Agriculture, yielded at the rate of 41⅓ bushels per acre on similar, though more frequently cropped, soil. A bag of this seed weighed 252 lbs. A bushel of seed was sown to the acre with an ordinary seed-drill and with it about 150 lbs. of bonedust were applied.

THE ORCHARD.

During this season there has been an abundant supply of fruit, especially of peaches and apricots. Although more than half of the young apricots were pulled off in order to increase the size of the remaining ones, the crop was exceedingly large. Unfortunately, there was very little demand this season for these fruits, so that prices were low. A small canning plant would have been very serviceable, in order to preserve the surplus fruit for consumption during the winter. A quantity of the fruit was dried, some made into jam, and the rest canned or bottled in a somewhat homely way.

The aphis was not very troublesome this year, and there was very little sign of disease.

During the summer months, very few vegetables will grow, as we have no water to spare for them. The asparagus seems to thrive very well, and is quite fresh and green looking, although the season has been so dry.

In addition to the results of the experimental work published, I have, perhaps, as much again to bring under notice in due course, as some of the experiments carried out require the lapse of several seasons before any practical results may be deduced from them.

I must again acknowledge my indebtedness to Mr. Wm. Farrer, of New South Wales, for his kindness in supplying me with some of his crossbred wheats for trial. Other gentlemen have forwarded samples of seed for experimental purposes, and to these I must also express my thanks.

Numerous experiments have been carried out with plants other than cereals, and I hope, in my report for 1900, to give the results of several seasons' work.

FIELD CROPS.—WHEATS.—Dookie Agricultural College Farm, Season 1899.

Number of Field.	Name of Variety.	Weight per Bushel.	Date Sown.	Rate of Seeding per Acre.	Manures used, &c.	Date Harvested.	Yield per Acre.	Remarks.
		lbs.						
No 2	Tuscan (white) ..	..	April 18 to April 22	1 bus.	1½ cwt. superphosphate, Victorian made	Nov. 2 to Nov. 13	1½ tons hay	Cut for hay. Excellent quality.
	Frampton	..		1 „	1½ cwt. superphosphate, Victorian made		½ tons hay	Cut for hay. Excellent quality.
	Australian Talavera ..	65		¾ „	1½ cwt. superphosphate, Victorian made	Dec. 11	18½ bus. ..	Suitable for hay crop. Grain of good quality. No 2 field has been in cultivation for twenty years.
No. 14	Farmers' Friend ..	64½	April 25 to April 28	¾ „	70 lbs. Victorian superphosphate	Dec 5 to Dec. 9	16 „ ..	Large plump grain; suitable for northern districts.
	Purple Straw ..	65		¾ „	70 lbs. Victorian superphosphate		19 „ ..	A good all-round wheat.
	Ward's Prolific ..	65		¾ „	70 lbs. Victorian superphosphate		18 „ ..	A rust-resisting variety, red chaff; grain fair sample.
	Marshall's No. 3 ..	64		¾ „	70 lbs. Victorian superphosphate		19 „ ..	A good yielding variety; tapering ears.
	Defiance	65½	April 28	¾ „	70 lbs. Victorian superphosphate		17 „ ..	Grain medium size; brownish chaff. No. 14 field is also an old cultivation field.
No. 16	Australian Talavera ..	65	May 26 to May 31	¾ „	No manure ..	Dec. 18 to Dec. 21	11 „ ..	The early-sown manured crop gave 18½ bushels in No. 2 field.
	Hudson's E.P.S. ..	64		¾ „	No manure ..		12½ „ ..	A useful variety. No. 16 field has been cropped once before.
No. 17	Sullivan's Early Prolific	66	May 15	25 lbs.	No manure ..	Dec. 11	9 „ ..	Shed grain; straw on weak side; grain good size.
	Early Para	67	May 15	¾ bus.	No manure ..	Dec. 11	10 „ ..	Straw rather weak; usually yielded well.
	Stem King	64	May 15	¾ „	No manure ..	Dec 11	7 „ ..	Straw weak; shed grain considerably.
	White Lammas ..	66	May 16	¾ „	No manure ..	Dec. 12	19⅓ „ ..	Large good grain; good hay straw.
	Zealand	67	May 16	¾ „	No manure ..	Dec. 12	16 „ ..	Large grain; stools very little.
	Steers Early Purple Straw	65	May 17	¾ „	No manure ..	Dec. 13	17 „ ..	Good grain, not very suitable as a hay wheat; straw very purple.
	Allora Spring ..	64	May 17	¾ „	No manure ..	Dec. 13	13 „ ..	Grain plump, small; sheds very much; ears have reddish or brownish chaff. No. 17 field was cropped for the first time this season Ground fallowed. All crops were drilled in.

EXPERIMENTAL CROPS.—WHEAT.

Dookie Agricultural College, Season 1899.

No. of Field.	Name of Variety.	Date Sown.	Rate of Seeding per Acre	Manures Applied.	Weight per Bushel Dressed Seed.	Date Ripe.	Rate of Yield per Acre.	Remarks.
			bush.		lbs.		bush. lbs.	
No 6..	1. Austenlee ..	May 23	¾	1 cwt. bonedust	..	Nov. 27	..	Mostly destroyed by sparrows; medium early; purple straw, bald.
	2. District ..	,,	¾	,,	..	Dec. 5	..	Mostly destroyed by sparrows; grain sheds a little; yellow straw, bald.
	3. Fillbag ..	,,	¾	,,	..	,, 5	17 49	Sparrows troublesome; grain sheds a little; purple straw, bald.
	4. Purple Straw No. 1	,,	¾	,,	..	,, 4	22 47	Grain sheds a little; purple straw, bald.
	5. ,, No. 5	,,	¾	,,	..	,, 4	18 22	Grain sheds a little; purple straw, bald.
	6. Andros	,,	¾	,,	..	,, 4	20 36	Yellow straw, bearded.
	7. Yellow Essex No. 1	,,	¾	,,	65	,, 4	27 13	Yellow straw; grain much eaten by sparrows; large grain.
	8. Hermit	,,	¾	,,	64	,, 4	20 36	Brittle straw.
	9. Yellow Essex No. 2	,,	¾	,,	65	,, 4	27 14	Yellow straw; grain much eaten by sparrows.
	10. Ranji (a).. ..	,,	¾	,,	..	Nov. 21	12 8	A very early variety; suffered from sparrows' attacks; sheds grain.
	11. ,, (b).. ..	,,	¾	,,	..	,, 21	14 8	
	12. Red Tuscan ..	,,	¾	,,	65½	Dec. 4	23 51	Yellow straw; 65½ lbs. to the bushel.
	13. Purple Straw Tuscan	,,	¾	,,	65½	,, 4	26 30	Yellow straw; grain sheds a little.
	14. Battleaxe ..	,,	¾	,,	66	,, 4	30 55	Purple straw, good ears.
	15. Bluestem ..	,,	¾	,,	63	,, 5	28 16	Straw of good length.
	16. Budd's Early ..	,,	¾	,,	67	,, 5	23 51	Brownish ears.
	17. Steinwedel ..	,,	¾	,,	66	,, 4	19 52	Sheds grain considerably.
	18. Maffra.. ..	,,	¾	,,	65½	Nov. 28	16 47	Fine straw; early.
	19. Gatton	,,	¾	,,	66	,, 27	22 5	Yellow straw; early.
	20. Forest	,,	¾	,,	66½	Dec. 1	22 58	Yellowish straw.
	21. Warroo A. ..	,,	¾	,,	..	,, 1	15 54	Yellowish straw.
	22. Oakshott's Champion	,,	¾	,,	65½	,, 8	26 30	Yellowish straw.
	23. Northern Champion	,,	¾	,,	65½	,, 6	30 55	Purple straw, bald ear.

Experimental Crops.—Wheat—*continued.*

No. of Field.	Name of Variety.	Date Sown.	Rate of Seeding per Acre.	Manures applied.	Weight per Bushel Dressed Seed.	Date Ripe.	Rate of Yield per Acre.	Remarks.
			bush.		lbs.		bush. lbs.	
No. 6 ..	24. Californian Chili ..	May 23	¾	1 cwt. bonedust	64½	Dec. 9	26 30	A Tuscan type of wheat.
	25. Frame's Early ..	,,	¾	,,	64	,, 9	23 51	A Tuscan type of wheat.
	26. Tardent's Blue ..	,,	¾	,,	63	,, 9	21 12	A velvet chaff variety, with long tapering ear.
	27. White Tuscan ..	,,	¾	,,	64	,, 9	28 16	A well-known good all-round wheat.
	28. Allora Spring D. ..	,,	¾	,,	64	,, 5	22 5	A later variety than the ordinary one.
	29. Rattling Jack ..	,,	¾	,,	65	,, 4	25 10	A rather clubbed purple straw wheat.
	30. Pride of Barossa ..	,,	¾	,,	67	,, 6	22 54	Open ears, somewhat rough and tapering.
	31. Early Para ..	,,	¾	,,	66	,, 1	24 17	Rather weak in the straw.
	32. Steinwedel x King's Jubilee	,,	¾	,,	67	,, 1	19 14	Weakish straw.
	33. Kestrel Early Strain	,,	¾	,,	67½	,, 3	18 33	Smallish grain.
	34. Perraf. B. ..	,,	¾	,,	66	,, 2	16 42	Small grain.
	35. Comeback ..	,,	¾	,,	66¾	,, 4	16 17	Grain has passed an excellent milling test. Small.
	36. Nutcut	,,	¾	,,	67	,, 6	20 22	Three bags of a nice plump grain were obtained. The grain is small and flour from it of good strength.
	37. Victorian Wards ..	June 1	¾	,,	66½	,, 6	19 30	Brownish grain.
	38. Quartz x Ward's White	,,	¾	,,	66	,, 4	19 40	Very brown grain.
	39. G. of 97	,,	¾	,,	65	,, 4	20 4	A good yielding variety, allied to Rattling Tom.
	40. 5 of 97	,,	¾	,,	66½	,, 4	18 25	A variety of Purple Straw.
	41. White Flanders ..	,,	¾	,,	67	,, 8	15 27	Somewhat similar to White Naples, but not as good.
	42. Robbin's R.R. ..	,,	¾	,,	66	,, 5	19 53	Small grain. Appears to yield very well.
	43. Leake's R.R. ..	,,	¾	,,	66	,, 4	19 47	A well-known variety.
	44. Golden Drop ..	,,	¾	,,	63	,, 9	12 11	The seed of this was accidentally placed in water too hot when using the hot-water treatment for bunt.

No. 6..										
	45. *Richelle Blanche Hatif*	June 1	2	1 cwt. bonedust	66½	Dec.	5	19		A French variety.
	46. Beryl	,,	3	,,	64½	,,	8	21	20	A close head.
	47. Murray River ..	,,	1	,,	66½	,,	6	19	8	A good yielding variety.
	48. Odessa Sans Barbe	,,	3	,,	64	,,	8	18	46	
	49. Fultz ..	,,	4	,,	61½	,,	9	15	5	Grown considerably in Canada and United States.
	50. White Essex ..	,,	3	,,	65	,,	8	10	1	This block was much eaten by rabbits. Ripened unevenly.
	51. Rattling Tom ..	,,	3	,,	65½	,,	8	19	0	A good yielding variety.
	52. Craig's R. R. ..	,,	1	,,	66	,,	10	15	9	Small grain.
	53. Goldsmith's Pedigree ..	,,	4	,,	63	,,	8	19	48	Inclined to rust.
	54. Frampton ..	,,	3	,,	66	,,	8	15	30	A good hay wheat.
	55. Early Purple Straw D.A.C. ..	,,	4	,,	68	,,	4	16	55	Grain tends to shed.
	56. Braemar ..	,,	3	,,	64	,,	10	16	18	A variety tried this season. Not pure.
	57. Fillbag ..	,,	1	,,	65½	,,	4	18	28	A good yielding variety.
	58. Little Club ..	,,	1	,,	66½	,,	8	13	54	Ears small and clubbed.
	59. F (1) ..	,,	4	,,	66	Nov.	16	17	6	A very early, red chaff, bearded variety.

The above 59 varieties were drilled in with an ordinary seed-drill with manure attachment, after being tested. The crops were horse-hoed with one of Frank's machines. The drills were 7 inches apart. I consider the cultivation due to the horse-hoeing materially increased the yields. This season (1900) special experiments will be carried out in respect to horse-hoeing, harrowing, and "no after cultivation."

COMPARATIVE RESULTS.

Experiments with Early Maturing Varieties of Wheat, Sown late. Manured with Victorian Superphosphate at the rate of 1 cwt. per Acre. Land Hoed Three Times.

Name of Variety.	Date Seed Sown.	Date in Ear.	Date in Flower.	Date when Ripe.	Rate of Yield per Acre.	Remarks—Season 1899.
	1899.	1899.	1899.	1899.	bush. lbs.	
1. Hudson's Early Purple Straw..	June 20	Oct. 25	Nov. 4	Nov. 29	29 32	The hot winds rapidly ripened varieties, and some of them prematurely.
2. Steer's Early Purple Straw ..	,, 20	,, 25	,, 4	,, 29	23 6	
3. Early Purple Straw	,, 20	,, 22	Oct. 28	,, 29	17 58	
4. Early Baart	,, 20	,, 22	,, 26	,, 29	25 40	
5. Early Para	,, 20	,, 22	,, 26	,, 29	25 40	
6. Frame's Early	,, 20	,, 30	Nov. 5	,, 29	20 32	
7. Steinwedel x Kin 's Jubilee ..	,, 20	,, 14	Oct. 21	,, 27	20 32	
8. Carbine	,, 20	,, 17	,, 21	,, 27	25 40	Too difficult to thresh.
9. Adora Spring	,, 20	,, 22	,, 26	,, 29	5 14	Shed grain very much.
10. Output	,, 20	,, 22	,, 28	,, 29	28 14	
11. Ranji B	,, 20	,, 9	,, 13	,, 29	23 6	
12. Yandilla	,, 20	,, 17	,, 22	,, 29	15 24	
13. Straightvote	,, 20	,, 17	,, 26	,, 29	30 48	
14. Whitelight	,, 20	,, 25	,, 30	,, 26	5 4	Grain threshed out.
15. Kestrel Early	,, 20	,, 30	Nov. 5	,, 30	7 42	Grain threshed out.

EXPERIMENTAL FIELD.

Dookie Agricultural College, Season 1899.

No. of Experiment.	Name of Variety.	Manures Applied.	When Sown.	Rate of yield per Acre.	Remarks.
				bush. lbs.	
	Rattling Tom ⅛ acre ..	No manure	June 1	13 1	A wheat that has yielded very well for several seasons.
	,, ,, ..	1 cwt. Victorian superphosphate ..	,,	19 15	
	,, ,, ..	1 cwt. bonedust	,,	19 6	
	,, ,, ..	No manure	,,	13 30	
	,, ,, ..	1 cwt. Rawson's	,,	16 6	
	,, ,, ..	1 cwt. Thomas' phosphate	,,	18 0	
	,, ,, ..	1 cwt. bonedust, ½ cwt. nitrate soda ..	,,	17 42	

FIELD CROPS.—BARLEY.

Dookie Agricultural College, Season 1899.

Number of Field.	Variety of Barley.	Date Sown.	Rate of Seeding per Acre.	Manure applied per Acre.	Date Harvested.	Yield per Acre.	Remarks.
50 acres. No. 18 ..	Chevalier M. ..	May 4th to May 9th	1½ bus.	½ cwt. bonedust ..	Nov. 22nd to Nov. 24th	27 bus. ..	A good sample for malting purposes.
	Prize Prolific ..		,,	,, ..		28 ,, ..	A good sample. The barleys were more or less frosted.
	Chevalier F. ..		,,	,, ..		28 ,, ..	A good sample.
	Chevalier D A.C.		,,	,, ..		25 ,, ..	Grain slightly larger than above. Straw purple, ear erect. This crop was severely frosted. No. 18 Field has been about four years under cultivation.

FIELD CROPS.—OATS.

Season 1899.

Number of Field.	Variety of Oats.	Date Sown.	Rate of Seeding per Acre.	Manure applied per Acre.	Date Harvested.	Yield per Acre.	Remarks.
No. 12 ..	Algerian Oats ..	April 12th to April 15th	1½ bus.	1 cwt. superphosphate (Victorian)	Nov. 16th to Nov. 21st	50 bus. ..	Straw good length. Grain good sample. Nos. 12 and 13 Fields are very old cultivation fields.
No. 13 ..	Algerian Oats ..	May 9th to May 13th	,,	1 cwt. bonedust ..	Nov. 27th to Nov. 30th	32 ,, ..	Straw fair length. Grain rather better than that from No. 12.

COMPARATIVE TESTS WITH VARIETIES OF OATS.

Dookie Agricultural College, Season 1899.

No. 5.	Variety of Oats.	Date Sown.	Rate of Seeding.	Manure Applied.	Date Ripe.	Rate of yield per Acre.	Remarks.
						bus. lbs.	
¼ ac.	Newmarket White	9th May, 1899.	1¼ bushels	1 cwt. bonedust	Nov. 28	40 0	The rain that fell late in the spring had much to do with the filling out of the grain, for, with the exception of Algerian and Calcutta, the oats tested have, so far, proved unsuitable for dry districts.
¼ ac.	Bonanza.. ..				Nov. 28	40 35	
	Golden				Dec. 6	40 15	
	Winter				Dec. 6	35 33	
	Calcutta.. ..				Nov. 5	58 0	
	Algerian.. ..				Nov. 28	67 4	
	Surprise.. .				Nov. 23	46 25	
	Royal Cluster ..				Dec. 6	31 34	
	Triumph White ..				Dec. 9	17 43	
	French Grey ..				Dec. 9	30 5	
	Black Tartarian ..				Dec. 6	42 26	
	Skinless or Naked				Nov. 27	39 32	

The Newmarket White Oat, on the larger experiment, gave the same return. This oat took first prize at a leading show in England the season before it was sown here. It grew well, and stood about 5ft. high when cut. The grain only weighed 41 lbs. per bushel.

The Bonanza White Oat grew nearly the same height as the Newmarket White Oat, and the seed weighed 49 lbs. per bushel.

The above oats were horse-hoed and kept free from weeds.

COMPARATIVE TESTS WITH FEED AND MALTING BARLEYS.

Dookie Agricultural College, Season 1899.

—	Variety of Barley.	Date of Sowing Seed.	Rate of Seeding.	Manure Applied.	Yield per Acre.	Weight of Seed per Bushel.	Remarks.
			bush.		bush. lbs.	lbs.	
1 ac.	Kinver ..	3rd May, 1899	½	Bonedust	40 0	55½	Very clean seed.
¾ „	Burton Malting ..		„		32 0	54½	Seed germinated badly. Seed not pure.
¾ „	New Golden Grain		„		42 0	54	Very clean seed.
¼ „	Hallett's Pedigree		„		41 20	57	Very clean seed. Shorter straw than those above.

The above barleys were grown from imported seed, with the exception of Hallett's Pedigree, which was imported by the Hon. George Graham, M.P., the season previous, and the above was from seed sown here late in the season 1898. The above blocks were under Cow Peas during the previous season.

Comparative Tests with Feed and Malting Barleys—*continued.*

MALTING BARLEYS.

—	Variety of Barley.	Date of Sowing Seed.	Rate of Seeding per Acre.	Manure Applied.	Date Ripe.	Rate of Yield per Acre.	Remarks.
						bush. lbs.	
1/20 ac	Hallett's Pedigree	May 9	1 bushel	1 cwt. bonedust	November 21	39 0	The hot winds ripened up the barleys suddenly, and thus the comparative ripening period of each under normal conditions could not be obtained.
,,	G lden Drop ..					30 4	
,,	Burton ..					10 40	
,,	New Golden Grain					25 19	
,,	Kinver ..					20 34	
,,	Ch valier F. ..					23 35	
,,	Cheva ier D.A.C...					28 10	
,,	California ..					21 11	
,,	Woburn ..					20 10	
,,	Golden Melon ..					20 34	
	FEED BARLEYS.						
1/20 ac	Algerian No. 1. ..	May 9	1 bushel	1 cwt. bonedust	Nov. 22	29 36	The sparrows more or less troublesome to all the barley.
,,	Algerian No. 2 ..				,,	2 19	
,,	Selected Cape ..				Nov. 21	42 38	
,,	Oregon ..				Nov. 22	24 15	
,,	Sea of Azov ..				,,	13 31	
,,	Skinless or Naked				Nov. 15	—	Weak straw. Not harvested—spoiled by sparrows.

CHEVALIER F BARLEY.

Dookie Agricultural College.

No.	Manures applied with Seed, 2nd June, 1899—Two Cultivations.	When reaped.	Rate of Yield per acre.
			bshls. lbs.
1	2 cwt. bonedust	30th November, 1899	33 44
2	No manure		20 1
3	2 cwt. superphosphate		43 6
4	2 cwt. Thomas' phosphate		32 17
5	No manure		23 5
6	2 cwt. Geelong fertilizer		24 32
7	2 cwt. Peruvian guano		41 29
8	No manure		24 32
9	2 cwt. lime		24 32
10	½ cwt. sulphate ammonia		16 17
11	No manure		21 28
12	½ cwt. nitrate soda		21 28
13	¼ cwt. potash chloride		21 28
14	No manure		21 28
15	2 cwt. fowl manure		21 28
16	2 cwt. Peruvian guano		52 18
17	No manure		20 1
18	2 cwt. bonedust, ½ cwt. nitrate soda		24 32
19	2 cwt. bonedust, ½ cwt. sulphate ammonia		24 32

CHEVALIER F BARLEY—*continued.*

No.	Manures applied with Seed, 2nd June, 1899—Two Cultivations.	When reaped.	Rate of Yield per acre. bshls.	lbs.
20	No manure	30th November, 1899	20	1
21	2 cwt. bonedust, ½ nitrate soda, ¼ potash chloride ...		26	9
22	2 cwt. superphosphate, ½ sulphate ammonia ...		30	40
23	No manure		15	20
24	2 cwt. superphosphate, ½ sulphate ammonia, ¼ potash chloride		27	36
25	2 cwt Thomas' phosphate, ¼ cwt. potash chloride ...		26	9
26	No manure		18	24
27	2 cwt Thomas' phosphate, ½ soda nitrate, ¼ potash chloride		20	40
28	2 cwt Geelong fertilizer, ¼ cwt. potash chloride ...		21	28
29	No manure		18	24
30	2 cwt. Geelong fertilizer, ½ sulphate ammonia, ¼ potash chloride		16	47
31	3 cwt. Geelong fertilizer		26	9
32	No manure		20	1
33	2 cwt. lime, ½ cwt. nitrate soda		20	1
34	1 cwt. bonedust		28	0
35	No manure		20	1
36	1 cwt. superphosphate		32	6

With respect to the manurial tests with Chevalier barley, I may say that, although the grain was late sown, being put in on the 2nd June, 1899, it had a favorable season up to a certain point, which caused a good growth in most late-sown crops, in so far that the grain filled up well. However, late frosts were very severe for a time, and in low-lying parts the barley and wheat were severely checked. The frosts were followed by exceptionally drying winds and severe dust storms, one of which passed over on the day that the Royal Commission on Technical Education visited the college. The effect of the winds on the barley varied according to its state of ripeness. Thus, the plots manured with phosphatic manures were well forward and nearly ripe when the hot winds were at their worst, and were but little affected; whilst those manured with phosphatic and other manures combined were more affected; and the drills not manured, and those manured with nitrogenous and potassic manures, were the most affected. Possibly, had the season been a good one throughout, the yields of the latter would have been much improved: as it was, the seed was considerably shrivelled, and lacking in weight. The barley not manured appeared to withstand the hot blasts better than that manured with the nitrogenous manures, as the latter, from its ranker growth, was more sappy and delicate.

The hot winds, coming as they did, ripened up all the manured drills of barley in a day, and in four days after, all the straw of the drills unmanured was ripe. Had the season been normal the nitrogenous-manured drills of barley would probably have been several days later in ripening than the drills not manured. Most of the plants in the drills manured with phosphatic manures came into ear from the 21st to the 24th October, 1899, whilst those plants in drills not manured or manured with nitrogenous and potassic manures only, were not in ear until the 29th October, 1899.

The presence of phosphatic manures appears to stimulate the plant to the early reproduction of seed, as experiments for a number of years have indicated. It seems that the presence of the phosphoric acid is of primary importance in the formation of tissues that play a prominent part in elaborating starch and some other nutrients found in grain. Nitrogen appears to delay the ripening process of the grain, and stimulates the reproduction by stooling or tillering, thus inciting into growth latent buds, which, in hot districts, use up a considerable amount of moisture, that can be ill-spared by the plants. There is scope for much original work in reference to the action of the constituents of manures in the elaboration of plant tissues and seeds, and this is of special interest in regard to the improvement of malting barleys, as there is no doubt but that by selection, and by the aid of manures, certain characteristics may be intensified in varieties, fitting them for the making of beers and spirits, having certain flavours and other characteristics peculiar to them, due to the greater or less amount of nitrogenous or other matter present. Environment, we know, causes insidious changes in varieties ; in the one place intensifying, and in another retarding the development of characteristics peculiar to them.

The want of opportunities and facilities for carrying out such delicate and difficult work is apparent ; and, although the demand for it in this country has not arrived, it is only a question of time when it will, in order that practical advantage may be taken of the knowledge gained, as it probably is in the older countries at the present day.

By Authority: Robt. S. Brain, Government Printer, Melbourne.

COUNCIL OF AGRICULTURAL EDUCATION, VICTORIA.

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REPORT

BY THE

PRINCIPAL OF THE SCHOOL OF HORTICULTURE

(C. BOGUE LUFFMANN),

FOR THE YEAR ENDING

31ST DECEMBER, 1899.

By Authority:
ROBT. S. BRAIN, GOVERNMENT PRINTER, MELBOURNE.
10049.

REPORT BY THE PRINCIPAL OF THE SCHOOL OF HORTICULTURE.

(*C. Bogue Luffmann.*)

The school is designed for the teaching and training of orchardists, gardeners, and managers of fruit-growing and small private estates. It is situated in a near suburb of Melbourne, and has a good tram and train service.

The estate comprises upwards of 40 acres of varied land, of which twenty are at present devoted to fruit trees, vegetable culture, a nursery, and flower gardens.

New stables, plant houses, frames, sheds, and other buildings have recently been erected. Class, dressing, luncheon, and work rooms form portion of a large pavilion, wherein shelter and occupation are found in adverse weather.

Class-room instruction is given in horticultural science, vegetable pathology, botany, chemistry of soils and plants, physical and commercial geography, entomology, measuring, levelling, designing and plotting of homesteads, orchards, and garden areas, and the most approved methods of raising and managing fruit trees and plants. Practical work includes the propagation and management of orchard trees, citrus, table grapes, bush fruits; harvesting, storing, packing, marketing, drying and canning of fruit, vegetable culture, clearing, grading, and trenching of land, management of soils, manures, drainage, water conservation and distribution, irrigation, villa gardening, and care of domestic animals.

Rules for Admission.

Students of both sexes are admitted—youths over fourteen and women over sixteen years of age. Students may enter from one to three years. Those taking the full course and passing the necessary examinations are granted a diploma and recommended to suitable positions. Male students are enrolled at any time, but it is advisable to join at the commencement of the year. Instruction is free. Male students deposit £5 as a guarantee for their good behaviour. Students leaving the school within one year forfeit their deposit money.

Women students attend thrice weekly from 2 to 5 p.m. Male students daily, except Saturdays, from 9 a.m. till 5 p.m.

Women students have to provide themselves with the uniform dress and pocket tools. Diaries must be kept, and approved text-books purchased by all students. The year consists of a ten months' course—February to December. All students must strictly conform to the rules of the school. Students are non-resident, but good accommodation exists in the locality. Applications for admission should be made to the Secretary for Agriculture, Public Offices, Melbourne.

The year opened with thirteen male students ; one death occurred, and one student completed his course of three years, and was placed on a large fruit-growing estate in Queensland.

A feature of the year has been the opening of the school to women students. In February 72 students were enrolled, upwards of 40 entering for the full course. These have been taught designing, forming, and maintaining villa gardens ; vegetable culture, and the general management of orchard trees. Several orchard blocks have been pruned by women students, and they have also been successful in other branches. The essays sent in (upwards of 50) afford ample proof of the capacity and earnestness of the students. Many of the papers are so good that it has been deemed advisable to include examples in an appendix to this report. The final examination, in which 62 students took part, comprised a list of 30 subjects. The result was highly creditable, one student obtained 149 out of a possible 150 marks, four others 140 marks, and 27 over 120 marks.

Two or three junior boys gave proof of a good capacity for horticultural work, and the women students succeeded remarkably well, when it is borne in mind that they received only bi-weekly instruction.

The result of the year's work is extremely encouraging, and now that the possibilities of this institution are fully recognised, an increased number of students will be attracted to it, and the teaching they receive must produce good results in improved methods of culture, handling of fruit, and horticulture generally.

The course of class-room instruction consisted of 150 lectures, illustrated by various drawings, diagrams, and living subjects. (For examples of lessons see Appendix.) All class-room instruction has been regularly supported by field demonstration and practice, and, as a consequence, many students have become as proficient in carrying work

to a successful issue in the field as in writing an essay on the same. Students are taught to know the meaning and value of every operation on the soil or plant.

Class-room teaching has embraced all the work of the year, and has been strictly in accordance with local conditions, resources, and market requirements. The comprehensive nature of the subjects dealt with may be gathered from the essays and examination papers. (See Appendix.)

The practical work of the year has been extensive, varied, and thorough—including the grubbing, clearing, grading, draining, trenching, manuring, plotting, and planting of land for various trees and crops. Also the formation of and renovation of lawns, shrubberies, and borders. The mode of forming, developing, and maintaining of profitable design in various fruit trees, has been systematically practised, and the citrus family and the grape vine dealt with in accordance with their needs in this colony.

Grafting, budding, and various methods of propagation have been carried out at suitable seasons.

Vegetables have been grown on an extensive scale, as these, having to pass through various stages of growth in a brief period, are a fertile source of instruction to the student.

The treatment of soil and plants for the prevention and cure of disease has been regularly taught and practised. Extensive reforms and additions have been made to the working plant, orchards, and gardens. A drainage system has been instituted, together with manure and litter-saving pits, so that the greatest economy may obtain in conserving heart and value in the soil.

Upwards of 500 fruit-growers have called for instruction in various branches of orchard work, and about 600 letters on subjects of horticultural interest have been sent to inquirers during the year.

New and standard varieties of fruit have been distributed in early autumn and late winter months.

The fumigation of trees, under the Vegetation Diseases Act, has been carried out at the school.

Several applications have been made for students as managers of fruit-growing estates and directors of private gardens, and it is evident that there will be no difficulty in placing those who are fully qualified.

Subjects for Competition, 1899.

Senior Students.

1. Essay: Value of grading, draining, manuring, and regular cultivation of the soil. (Three to four pages foolscap.)
2. Essay: Select twelve most profitable fruits, stating districts in which they can be grown, and what markets are open to them.
3. Essay: The objects of winter and summer pruning of deciduous fruit trees.
4. Practical work, most skilful preparation of soil, planting and pruning of trees.
5. Principles of horticulture and vegetable pathology.
6. Botany applied to horticulture.

Junior Students.

1. Essay: Principles of pruning established apple, peach, and lemon trees. (Four to six pages foolscap.)
2. Essay: Mode of preparing and maintaining fertility in soil, Victorian lowlands. (Four to six pages.)
3. Essay: Six worst local pests (animal) with remedies. (Four to six pages foolscap.)
4. Oral examination in fruits of commercial value.
5. Best collection of injurious insects and fungi.
6. Competition in hoeing, raking, and digging.
7. Best forecast of work to be done from week to week.
8. Most regular and punctual attendance and interest displayed in work.

Women Students.

1. Essay: Lemon Culture. (Four to six pages foolscap.) Points—Best class of soil, preparation and maintaining of soil, situation, climate, moisture, stocks, best sorts, forming young trees, pruning trees in bearing, cleaning, harvesting, markets open, &c., &c.
2. Essay: Table Grape Culture. (Four to six pages foolscap.) Points—Site, class of food necessary, preparation of soil, mode of planting, training, pruning, management of wood, varieties, mode of protection, &c., &c.
3. Essay: How to choose, prepare, and maintain fertility in orchard and garden soils (Victorian lowlands). (Three to four pages foolscap.)

4. Essay: Asparagus and any other three vegetables, culture of. (Four to six pages foolscap.) Points—Choice of site and soil, depth of soil necessary, mode of planting, and general management.

5. Essay: Principles of Villa Gardening. (Four to six pages foolscap.) Plan in accord with climate, size, capital available, &c., &c. Villa front, 60 feet x 60 feet, or 80 feet x 40 feet, to be planned.

6. Practical illustration of hoeing, raking, and digging with fork and spade.

7. Practical illustration of pruning—Apricot, Peach, and Apple.

8. Practical illustration of pruning unstaked and trellised vines.

9. Special prize: Most able examination papers.

N.B.—All essays must be original. The substance of lectures and general discussions will be admitted, but copying from the text-books, standard works, or newspapers, or the inclusion of matter foreign to the subject of any essay will disqualify.

Three or more students must compete in each subject, or no prize will be given.

The value of any prize will correspond with the value of the essay.

A GROUP OF STUDENTS.

THE PROSPECTS OF COMMERCIAL FRUIT-GROWING IN VICTORIA.

(By C. Bogue Luffmann.)

Fruit-growing does not pay: so say the inexperienced who have tried it and failed. And in one sense they are right, for fruit-growing can never become a profitable industry until it is regarded as a business to be learned before being entered upon. When the principles and practice of the craft are well understood, and industry and natural capacity are brought to the work, success is sure.

The first thing to be considered is, what the world local and over-sea wants; next, how far it is possible to produce at a price which will defy outside competition: hence a knowledge of the producing and consuming areas of the world is indispensable to the commercial fruit-grower. If it is intended to produce for the local market alone, there is still the necessity for considering the competition which may have to be met from foreign or inter-colonial producers. What may be termed the comparative value of the resources of this colony must be clearly understood, as starting "on the blind" will prove not the worthlessness of the business, but the ignorance of those making the venture.

Victoria now produces more fruit than her population requires, it is therefore necessary that foreign markets be found. These markets are not numerous, but they are large enough to absorb far more fruit of certain kinds than united Australia will be able to supply for generations to come.

The populations and wealth, and hence the purchasing power, of the northernmost old-world countries are constantly on the increase; the favorable areas of production are eternally limited, and must form the permanent sources of supply. Victoria lies within the producing zone for those fruits which bulk largest in the trade of the wealthiest European and Asiatic nations. Her rivals in trade are poorer, able to work at a much lower rate of pay, content with a smaller trade profit, more expert in the art of production, and nearer to the consuming markets. Against these must be placed, as disadvantages—taxation of the heaviest description, costly land and no means to extend their areas, inability to purchase, or capacity to use, modern

and expeditious implements and machines, impoverishment of land, or lack of water, political disturbances, and, in some instances, incapacity for combination towards the furthering of foreign trade.

Victoria has for established rivals in the fruit trade, Southern France for prunes and bottled fruits ; Spain for muscatels, raisins, sultanas, figs, oranges, lemons, almonds, dried apricots, table grapes ; Italy and Sicily, oranges, lemons, almonds ; Turkey, figs, sultanas ; Syria, figs, oranges, almonds, dried apricots, sultanas ; Bosnia, prunes ; Greece, currants, almonds. These fruits are all naturally adapted to the geographical position and mean elevation of Victoria. Apples, pears, plums, cherries, and bush fruits are already a large source of profit, and succeed best in the more southerly, high, or best watered areas. Our conditions are foreign to those of our race, and our practice should conform to the methods of Southern Europe, rather than to those on the line of London, Paris, and Berlin.

Beyond a general knowledge of markets, the orchardist should be well informed as to the native wants of various fruits, and the opportunities which exist for their perfect development on a given area. In brief, he must be able to show that his own capacity, the soil, and situation, and the wants of the tree are in perfect accord. It is by bringing full and exact knowledge to operate upon naturally favorable areas that success is achieved. A popular fallacy exists that fruit will grow anywhere and anyhow in this colony. Nothing of the sort. We need the "eyes" of the country for those fruits most in request and profitable when grown. The fruit industry will make a permanent advance when we form a true estimate of our natural resources. Man succeeds when nature is on his side. It is ignorance, conceit, or youthful impetuosity which attempts the conquest of the desert. The influence of climate on soil, and on the fruiting powers and durability of fruit trees, are not sufficiently recognised. It is common to see fruit trees, of all kinds and degrees of vigour, placed in positions entirely out of correspondence to their native wants. The climate of Victoria, though more favorable to the production of the leading commercial fruits than any other of the Australian group, is, on the whole, a hard one, as is shown by the fact that nearly all orchard trees age prematurely, and die, or decline rapidly, if left untended. In further proof—excepting in rare situations—they will not

exist in a wild state. We learn from this that all domesticated fruit trees must be well placed and systematically cared for. Early maturity implies early decline, and the mistake is made in supposing a soil or district well suited to fruit trees because they grow quickly and produce early crops. A tree to be profitable must yield at least ten or twelve full crops of good quality fruit. Bad seasons will occur as the result of frosts or other climatic disasters, or of unskilful treatment. Allowing four or five years in coming to maturity, the necessary length of life will be twenty years. Of course, with certain kinds well placed, it will be much longer, and yet the average life of useful fruiting trees in Victoria is under twenty years. Herein lies a most important fact—every generation must plant for itself. Greater proficiency might extend the period, but the fact will eternally hold good that, use what skill and industry we may, every 20 or 25 years will see an entirely new lot of trees. It would therefore, be fatal to suppose that, the colony being well stocked with orchards, further planting is risky and unnecessary. Supposing the acreage under bearing trees to be 40,000 (it is much less) it would require an annual planting of 2,000 acres to maintain the existing supply, to say nothing of the increase which we are justified in encouraging. Admitting that a market exists for well-grown fruit, the most favorable methods of production and disposal have to be considered. An intelligent specialization of fruits in different localities is indispensable. Much-mixed orchards and small parcels should not be tolerated, where it is known that one or two kinds of fruit are well suited to a district, and the market is sure.

Bordeaux is famous for its prunes. Messina for its lemons. Malaga for its raisins. Smyrna for its figs. Seville for its olives. Each has a soil and natural set of conditions conducive to the greatest perfection of fruit, plus a people possessed of exact and uniform experience, largely intuitive, from long acquaintance with the subject. Victoria, in the same way, in so far as the soil and general conditions are uniform, would gain by having its peach, apple, pear, prune, or citrus districts. Where any form of labour becomes general in a community, defects are quickly eradicated, and the necessary knowledge remains as an inheritance for the young. These, starting from safe premises, succeed, and thereby give permenance to the industry.

The members of many old-world communities are joint-owners of buildings and implements necessary to the expeditious handling and storing of their produce. It is well for the individual to be self-contained, but the permanent value of fruit-growing in any locality depends on limiting the number of fruits grown, and adopting methods of cultivation, preparation, packing, and marketing of a uniform character. The producer of good material brings the market to his own door, as he is not put to the expense of hawking his wares, but can attract the trader to make purchases on the spot. The average man of small means and experience cannot secure the same measure of success from working alone that would come to him by combining with others.

Little reform can be hoped for on the part of existing growers who are widely scattered, and in the majority of instances are not entirely dependent on their orchards. It is with future work that we are most concerned. Here we would plead for a new order of producers (1) combinations of small growers, equipped to produce and dispose of their produce on the lines of the dairy-factory system; and (2) the merchant producer, who, having the means, only awaits the arrival of the skilful manager to assist him in the production of the raw material.

In France, Italy, Spain, and lesser communities on the Mediterranean and Adriatic, the merchant fruit-grower is a recognised and much-valued institution. He usually owns a considerable estate. He has liens and agreements to take the crops from many others. His larger knowledge and command of capital enable him to raise the best possible class of fruit from the local soil. The rules he lays down to be observed throughout every operation are known to all. All labour is classified, so that the most expert obtains in every operation. A working plant to turn every particle of material to account is here possible. Cider, vinegar, canned, dried, pickled, and preserved fruit are the profitable by-products of any large fruit-growing estate. The manager with exact knowledge, industry, and economy will show a profit. Victoria needs this class of man sorely; as, given men with ability to initiate and carry work to a successful issue, capitalists would not be wanting to enter upon the work of production. The future of the fruit industry depends, almost entirely, on the amount of intelligence and organization devoted to it.

We shall secure no good markets until larger quantities of higher average quality are produced from compact areas. Fruit-growing for profit demands more or less knowledge of the physiology of plants; the causes of health and disease; the nature and functions of the different parts of trees; the effects of climate on vegetation; the nature and variable composition of soil, and the effects on soil of heat, air, frost, water, light, manure, lime, and other chemical substances; draining, cultivating, weeds, neglect, and crops; familiarity with seasonable periods for every operation, harvesting, and marketing; acquaintance with fruits of commercial value; capacity; industry; to say nothing of detail which takes years to acquire and fix in the memory. If the foregoing are indispensable, it is presumptuous to regard commercial fruit-growing as a refuge for the ignorant.

Our first concern is to reduce existing material to proper order, to diminish, from year to year, the variety of fruits in each district; mere collections of sample lots being reserved to the amateur; to encourage the peach grower to go to the peach area, the citrus, or apple grower, to where these fruits are grown to greatest perfection, so that we may, as soon as possible, insure a steady market through combination and improved methods.

Fruit-growers should not isolate themselves. This has been the ruin of hundreds, and it will produce a majority of failures so long as it obtains.

The orchardist in a small or large way, should start with, or be able to command, skill and experience. If he has not these, let him work, learn, and then start. His reward will come sooner, and remain to him. If a fruit is good and marketable at a paying price, is suited to the soil and situation, and its cultivation is understood, let him stick to it, and get more, providing he has strength to do more work.

The prospects of commercial fruit-growing in Victoria are favorable to those who start with a sound knowledge of the industry.

CULTIVATING VICTORIAN ORCHARD LANDS.

(By C. Bogue Luffmann.)

Why do we cultivate?—

I. To clean the soil of weeds, which rob it of food and moisture.

II. To rid the land of various injurious insects and fungi.

III. To break up the hard hot surface, which hastens evaporation and prevents aëration.

IV. To free food stuffs lying in the soil.

V. To preserve an earth mulch, and so reduce the temperature and conserve moisture in the summer.

VI. To prevent impurities from souring the soil in winter.

VII. To enable water to permeate all the soil and carry food to the roots.

These are the ordinary and direct reasons why we cultivate in a dry hot climate. Capillaries, or tubes—due to contraction and expansion, and dependent on the degree of moisture and temperature of the air—exist in all but extremely sandy and dust-like soils. If these tubes are broken near the surface we prevent the escape of moisture.

Cultivating exposes a large proportion of soil to the air, hence it is sweetened. Orchard trees can thrive only where soil is in a free, sweet, and active state. There would be no growth of the roots—on which all the superstructure of the tree depends—did not the soil make a regular physical movement. All the food stuffs in the soil are quickened and made available by the presence of air, water, and heat. Decomposition and recomposition are constantly taking place in the calm and seemingly passive earth. In this sullen surface soil there is eternal change, bustle, and reform. Where it is not so nothing of value can grow.

All vegetable life may be described as the outcome of fermentation. This implies that all fruitful soils (in warm climates) are fermenting continually. In so far as this takes place, food stuffs are made available to the roots of plants.

IN THE LECTURE ROOM.

All sour soils are masses of fermentation, interfering with the growth of trees. Therefore, *violent* fermentation should not take place in the soil of the orchard. All sour land holds much plant food, but the sourness must cease, by means of elaborate cultivation, ere good results may be hoped for. Lime is most useful in sweetening sour soils, as it not only destroys the small life which promote this sourness, but also warms the soil, and thereby extends the growing period of the roots in winter.

The heavier and more moist the soil, the more frequently must its surface be dealt with—as all moist, close soils soon become sour, and exposure to air (combined with drainage) is the natural mode of sweetening them. Lime, by acting chemically on the soil, changes its foul particles into sweet edible substances for the roots of trees. Ashes, sand, and gravel also help in a more moderate degree, by keeping the soil open, and thus admitting air.

All domesticated fruit trees are healthy and profitable in proportion as they receive air, heat, light, moisture, sweet soil. All these, except light, are controlled by cultivation, and even where a soil is good, it cannot furnish useful crops without them. These five subjects, not exactly of the soil, are necessary to the production of all vegetable forms, the amount required by each differing only in degree.

Cultivation liberates, gathers, conserves food for plants. I. It liberates, by breaking clods and bringing different elements together, which apart would not form plant food. II. Cultivation gathers much light matter on the surface, which would otherwise be desiccated and blown away. III. Cultivation conserves—by retaining moisture to act on and prepare food stuffs during summer, and also by preventing weeds from using up the free properties of the soil.

Cultivating alone is a genuine means of enriching soil. Poor soil is made more fertile, and rich soil needs cultivating in order to keep down objectionable matter, such as rank weeds, which choke and foul it.

All orchard trees in dry climates require frequent and thorough cultivation.

In the cold European countries, orchard trees usually occupy damp meadow-like land; hence many argue that grassed orchards should succeed here. But similar *conditions* are rare in Victoria.

Where the climate is cool and moist, grass, growing all the year, provides a permanence for earth worms, and these

make myriads of tubes between the surface and the sub-soil. These tubes admit air—they carry down various elements which have been sweetened on the surface, and so secure health to the roots during summer. Under such conditions of climate, a most elaborate system of cultivation is performed by insects. In winter, these grassed orchards are saved from sourness by the perishing and cleansing frosts. The temperature falls so low that the bacteria, which foul the soil, are held in suspense; hence the soil of cold countries is, during winter, sweeter and more acceptable to the roots of trees than that of the temperate regions, where moisture combines with sufficient heat to favour the developing of much noxious matter.

Climate governs all our operations. Here a so-called grassed orchard would soon become hard as a brickfield, and a home for all orchard pests.

There are abundant examples of this fact. The importance of thorough and intelligent cultivation can never be overstated, as the tree depends entirely on the condition of the soil.

Cultivation has literally produced all the splendid vegetable forms which man enjoys. Think for a moment how little *wild* food man consumes in the cold and temperate zones. There was a crude sufficiency when he was a savage, but, with the coming of civilization, or living by artifice, the nature of his supply has changed completely. He cultivated something like the tiny hawberry till it became an enormous pear ; he dug round the primitive cabbage of half-a-dozen thin leaves until we have it as large and solid as a scuttle of coals. And so on throughout the multitude of plants man has subjected to his use. He has been feeding them, amid congenial surroundings, and they have grown.

Orchard lands should be cultivated in accord with their nature—as affected by climate—and the specific needs of various trees. All lands should be dealt with often enough to insure a perfectly free clean surface during summer, and to provide for the easy movement of roots at all seasons. The depth at which to cultivate depends on the nature of the soil, age, and nature of trees. Example.—Young trees cannot grow too fast; hence, cultivate to assist them in every possible way. With the trees established, and an inclination to make wood at the expense of crop, lighter cultivating —mere cleaning of the surface—would serve for a time, though, of course, the orchardist must discriminate between checking and starving the roots.

Soil Treatment the Year Round.

Mid and Late Summer.—In January we should find a clean loose surface. Preserve this by light cultivating, harrowing, or roller-disc work at short intervals. As trees are relieved of their crops fork up the hard patches formed around them.

Autumn and Winter.—In autumn a crop of weeds is almost unavoidable (though docks, couch, sorrel, and other perennial weeds must never be allowed), and in dry hungry soils they are to be desired, as they furnish humic matter, which assists in conserving moisture in summer. It is bad practice to plough heavy crops of weeds into badly drained and "slow" soil, as it produces sourness and injures roots. Heavy weeds should be mown and allowed to wilt, or better still, carted into a pit, rotted into a sweet mould, and then returned to the orchard.

If weeds are mown and raked up after the fall of the leaf the soil is kept warmer and sweeter as desired for peaches, apricots, cherries, and other trees sensitive to cold and wet.

Good cultivation prevents extremes of heat and cold, drought and moisture; therefore, cultivate to warm the winter soil. After pruning, plough deeply, away from the trees, cultivating or cross-ploughing again soon if soil runs together or weeds grow apace.

The object of winter cultivation should be to keep the ground open, warm, and sweet, able to receive and hold water in a dry warm district, and to prevent flooding and stifling of the roots in a cool region.

All the surface of an orchard must be dealt with in winter. A hand fork is the best tool to employ within the spread of the trees.

Spring and early summer.—In spring, reverse the ploughing, throwing the soil towards the trees, and cultivate, roll heavy lumpy soil, and harrow in regular order. Don't allow any weeds to grow at this season, or the soil to become hard and dry on the surface. No deep cultivating should take place in a dry district during the late spring or summer, as this has the effect of wasting moisture. Only where heavy and penetrating rains fall is it advisable to plough or cultivate deeply during summer.

Learn what plants like, and how to gratify their taste, and you have mastered the art of cultivating the soil.

THE ECONOMY OF DESIGN IN FRUIT TREES.

(By C. Bogue Luffmann.)

The substance of this paper, with numerous black-board and living illustrations, was given at Burnley to show the value of design in the framework of fruit-bearing trees. It does not deal with pruning in the ordinary acceptation of the term, as it stops with the shaping of the framework or foundation wood ; but, as longevity and an annual and abundant supply of high quality fruit depend entirely on the design of the tree, all orchardists should be conversant with this important subject.

The design of any fruit tree is not merely its outward form, as "Goblet," "Pyramid," "Half Globe," &c. It has an *interior structure*, on the nature of which depends its commercial value.

Every one dealing with trees for profit should know the functions, instinctive habits, and value of all their members. A tree above ground is composed of five more or less permanent parts ; that is, excepting its leaves, flowers, and fruit. It has—

I. A trunk ; from which proceed
II. Main branches ; from the mains spring
III. Secondary branches ; from the secondaries grow
IV. Laterals ; and from these
V. Spurs or shoots.

Fruit is borne on the latter types only, though they do not spring solely from the laterals, but may be produced direct from the secondaries, and, to an unimportant extent, on the main branches of some trees.

No matter what the variety, age, or type of a standard tree, these five kinds of wood compose its head, and the orchardist should know the suitable position and proportionate size of each part. All fruit is borne on light wood only, therefore this must be generally distributed throughout the entire head (saving the main branches). The spur, or shoot, is dependent on a certain amount of light and air for the development of its buds, their subsequent blossoming, and perfecting of fruit. It is also fruitful or fruitless, breaks into wood, or remains dormant, according to the volume of sap sent to it, and the size and vigour it acquires.

RESIDENCE OF THE PRINCIPAL.

All buds are, at an early period in their existence, in an indeterminate stage—that is, they may develop into flower or wood buds, according to the supply of sap, air, and light they receive. It is a common law of nature for the sap—which is the sustaining and wood-forming substance of the tree—to make the strongest growth where it ascends perpendicularly. Upright growth is, therefore, woody. It is weakness rather than strength which induces fruitfulness, and herein lies the clue to a profitable design. It lies between coarse strength and extreme weakness.

As upright growth is usually too strong to bear fruit, so all wood at a sharp angle from the perpendicular to the horizontal and dependent is more and more inclined to be fruitful, owing to the more moderate supply of sap resting about the buds, and the instinctive weakness of the part.

If upright growth is to bear fruit, it must be light. The trunk being the medium of supply to the super growth, branches placed directly over it are invariably the strongest, the rule being that they weaken according to the angle at which they stand from the perpendicular. In an economically designed standard fruit tree this law is reversed, the strongest branches ranging on the outside, the others weakening in regular order as they near the centre. By adopting this plan one secures a *permanently* shapely and highly profitable tree, as, where the framework is strong and broad, no difficulty exists in preserving an abundant supply of fruiting wood throughout the entire head; but if, on the other hand, light branches are encouraged on the outside, they fruit prematurely—the strong centre branches draw the sap away to no purpose, further development is impossible, they are quickly exhausted and disappear, leaving the tree in the form of an inverted pyramid, with a close and barren centre, and able to bear fruit over a meagre and unduly exposed exterior.

The size, shape, and fruit-bearing powers of a tree may vary considerably owing to native habit, resources of soil, position, and climate, but the interior economy should be well preserved in all circumstances. An appeal to reason, and the illustrations which, unfortunately, exist in almost every orchard, will show the comparative value of well-designed and irregularly formed trees. We see thick and thin branches of the same age standing at the same angle. One branch with a nest of spurs at its centre, another with a tuft of spurs at its point, or down one side, the other bare.

One side of a tree has three thick branches, the other side six or seven thin ones. Many trees have a fringe of fruiting wood near the crown, the inside being absolutely bare. These are not rare but general defects, in every case due to want of design and intelligent handling.

In every subject, there is a type of wood favorable to the production of fruit, at the least expense to the tree, therefore this type should be evenly distributed throughout every part except the main branches.

Where it is in the nature of a tree to make lanky pole-like branches these must stand well nigh perpendicular, and be of moderate length, or they will not support their crops, and preserve a fixed position. Every branch should be so placed, and given such a degree of vigour, that it will adhere to one position at all seasons, no matter how heavy the crop or wild the storm.

The difficulty of arranging branches is overcome when the resources of the soil and the native vigour and habit of any subject are thoroughly understood. Very few branches are needed, if they are well spaced. Three mains will yield nine secondaries—three light ones inside, and six of much greater vigour surrounding them. (Nine would prove too many in some trees. The age and spread of the tree determine the number of secondaries. They must always be sufficiently far apart to secure light and air on all sides when in full foliage.)

In designing a tree, it is necessary to note if the strongest secondaries occur on the *inside* or *outside* of the mains. An examination of living trees will show that nearly all peaches throw their secondaries *outwards* from the mains. Apricots are inclined to spread laterally. Apples and pears are most diverse, each variety calling for separate investigation.

Where secondaries spring *outwards* it is necessary to carry the mains higher and more perpendicular than when they spring from the inside. But the mains must not be laid in hurriedly, or the sap will be carried to the points, and thus prevent the formation of strong secondaries at base.

Where secondaries spring from inside, the mains are arranged as low and near the horizontal line as they can be conveniently carried without producing weakness and premature decline. Again, strong-growing varieties have their mains and secondaries at a sharp angle to the trunk, whilst weak and limp wood will modify the size of tree and call for more upright growth.

Carry all types of wood on uniform lines. Examples—All mains of equal size, length, and angle from trunk; all secondaries light in the centre and gradually thickening towards the outside; all laterals, shoots, and spurs strongest at the base of a branch and weakening as they ascend to the outside of the tree. All spurs and fruiting shoots at regular distances, established and growing wood alternating, otherwise there must be a feast and a fast through overcropping, or impotence of the light wood.

It is too much to hope that these rules will be literally observed by all orchardists, but the object is to explain the reason why fruit trees should be carefully planned and controlled.

The widest part of a fruit tree should be its base, a foot or so above the trunk. If it is objected that horse implements cannot be used and close cultivation secured, the reply is: Increase the height of the trunk, though not beyond 3 feet, as the climate demands low broad-based trees, which will screen their feeding area from the direct heat and desiccating winds of summer. If there is any inequality in the size and position of the mains, they should not be called upon to furnish the same number of secondaries. Example: A strong main may furnish three secondaries; another, considerably weaker or more horizontal, should yield two; the latter will then be of about equal size to the three furnished by the stronger main. A decidedly upright but indispensable main may be called upon to furnish several secondaries in order to exhaust it somewhat, after which a secondary or two of suitable size may be selected, and the others pruned away. Secondaries, again, must, in so far as they vary in size and position, be cropped according to their strength, otherwise the form of the tree will become irregular and less profitable. Laterals, shoots, and spurs are, in the same way, formed strong or weak, long or short, single or composite, according to the age and habit of the tree and the class of fruit desired.

The production and maintenance of fruiting wood is assured when the foundation is properly laid, therefore be particularly careful in dealing with the trees during the first three or four years. The right way absorbs no more money or time, whilst it assures the fullest possible return from all trees where cultural operations are well carried out.

APPENDIX No. 1.

HOW TO CHOOSE, PREPARE, AND MAINTAIN FERTILITY IN ORCHARD AND GARDEN SOIL.

(By Tessa Smith, First Year Student.)

The choice of orchard lands is one of the most important matters with which a fruit-grower has to concern himself, and an intelligent selection of site and soil at the outset is the first step towards that success in the industry to which he naturally aspires. The advantages of choosing both a favorable situation, a clean soil and one that is adapted to the requirements of what he intends to grow, can hardly be over-estimated, as it must seriously affect the subsequent success of the undertaking. We will assume that in selecting a site he has made up his mind what he wishes to produce, as that should necessarily influence his choice. If he intends devoting himself to the culture of any particular fruit, he would seek the site and soil best adapted to it; but if, as is more often the case, he wishes to grow the ordinary fruit or vegetables for the local market or for export, a class of soil should be chosen which, with moderate treatment, will bring about the required results. He must consider the climate and its influence on the soil, make himself familiar with all the local conditions and their direct bearing one upon the other, and this knowledge will guide him to a great extent in making a selection.

With regard to the site, let him carefully avoid a dead-level, sun-baked, wind-swept plain, where natural drainage is a thing unknown, and the task of supplying it is rendered doubly difficult; let him also avoid an abrupt hill-side, where, even with excellent natural drainage, there will still be the danger in winter of water washing down, causing a waste of food-stuff, and doing much damage to crops. Gentle undulating country or a mild declivity which is not too exposed to extremes of heat and cold, with unfavorable conditions of climate, will be found most suitable: add to this a deep soil over broken stone which will supply us with natural drainage. It is very necessary in this climate to have a deep soil where there will be more likelihood of moisture being conserved in dry weather, while drainage is one of the first essentials. Deep friable loam is an excellent class of soil and well adapted to most things. It is not half so difficult to maintain as a shallow one, no matter how rich the latter, it will want regular working. If at all moist it has a tendency to become sour, and will need frequent exposure and very efficient drainage; and the

FLOWER GARDENING.

richer it is the more abundantly will rank weeds grow in it; these also will always cause it to become foul, besides giving endless labour to get rid of them. But, wherever the site, and whatever the soil, let him be sure that it is perfectly clean and sweet, and, in order to insure this desirable state of things, begin by a thorough preparation of the soil. In planting a new orchard everything is practically in its infancy, therefore it is all the more necessary that the soil should be perfectly clean, sweet, and sanitary, and the fact of starting with an area free from insect pests and infectious matter of every kind will help him very materially to keep it in that condition afterwards. It is obvious that no better opportunity presents itself of thoroughly sweetening the land than before planting.

In the preparation of the land, clearing is generally the first labour involved, and after the trees have been grubbed out, they and all rubbish should be burnt; then the land should be ploughed and allowed to lie fallow for some time, and exposed to the beneficial influence of climate. Few impurities will survive this direct exposure, and, when a sufficiently long period has elapsed, he can continue operations.

Grading, trenching, and draining are all done with a view to maintaining fertility in the land. By grading, we prove and equalize the soil; for it can be readily understood that only by bringing about equal conditions in the soil can uniformly satisfactory results be hoped for. By trenching, we insure a sufficient depth of cultivation, and can, at the same time, work in the necessary manure and arrange and blend the soils so that the roots will be given every opportunity to move in the class of soil that is most likely to favour their development. By drainage, natural or artificial, the necessary degree of heat, air, and motion is given through the agency of water, which, passing freely through the soil, carries with it these three essential elements. After these have been thoroughly done, he can begin to plant with every hope that with skilful management he will obtain the best results; but the care of the soil must not cease with these first operations, the land should be submitted to a regular system of cultivation, it should be dug and ploughed frequently, and this for various reasons, viz.:—

That the weeds may not be allowed to choke the soil and deprive it of food and moisture.

To expose any impurities to the sun and air.

To enable air to permeate the soil.

To permit of moisture passing through easily to the roots, which it cannot do through a hard surface.

By dint of careful cultivation the fruit-grower will keep the land sweet; but another very important matter has still to be

considered, and that is the feeding of the soil ; here, a knoweldge of the soil, and a familiarity with the tastes of the plants are very necessary. Cultivation alone causes an amount of food stuff to be wasted, sun and wind are continually robbing it, to say nothing of the tremendous amount of nourishment drawn up by the roots to enable the tree to perfect its crop ; and it stands to reason that this supreme effort on the part of the tree must have the effect of draining the soil of the greater part of its resources and leaving it in a hungry state ; hence the great necessity of manuring and watering the ground at this period, that is, after cropping. As to the kind of manure the soil will require, so much depends on the nature of the soil and the character of the crop it is to carry, that it can only be dealt with in a general way ; but in this climate, in the low lands of Victoria, it can be safely said that humic matter is a property conspicuously absent in the soil, and if the orchard area will permit of space to be set apart as a fattening ground, where manure, burnt rubbish, litter of every description, of which leaf mould would form a valuable part, can all be thrown and dug in and allowed to decompose, this, when applied to the orchard land and well incorporated with the soil, will, in a great measure, make up for the deficiency. Lime is another property lacking, and is more expensive to supply, but it is extremely necessary where the soil is at all heavy and moist. In the dry season it is an advantage to mulch round trees, as by this means moisture is more easily conserved. Some vegetables grown in among fruit trees benefit them on account of the chemical properties they impart to the soil, peas, for instance, add nitrogen.

To maintain fertility in the land the fruit-grower should make himself perfectly familiar with the nature of the soil and the requirements of the trees, so as to be able to make up for the deficiencies in the former and gratify the tastes of the latter ; it would be wrong and unprofitable to ignore either ; therefore let him cultivate continually, and, by means of cultivation, he will ameliorate the conditions of the soil ; for it serves the threefold purpose of liberating, gathering, and conserving food for plants, and it is only by recognising its importance that he can hope for success, as the health, vigour, and fruitfulness of the tree depend almost entirely on the condition of the soil, and the most skilful pruning and management will not avail if he neglect to cultivate the land.

HOEING YOUNG CROPS.

APPENDIX No. 2.

VILLA GARDENING.

(*By Marian W. Thompson, First Year Student.*)

When making a villa garden, it is necessary to recognise the limitations of that particular branch of horticultural work, and carry out operations accordingly.

There are no natural features, such as abound in our mountainous districts, to assist us in our efforts to make home surroundings beautiful. The monotonous stretch of macadamized street surface, and a motley collection of inartistic house frontages, though, doubtless, of great utility from the contractor's point of view, do not afford much scope for the formation of beautiful gardens.

Space is limited, and we are restricted to planting certain varieties of shrubs and flowers, which must be hardy enough to resist the debilitating effects of our changeable climate.

Though we may admire delicate ferns and hothouse plants, with their exquisite flowers, we must be content to grow them in more congenial surroundings than in an ordinary suburban garden.

In order to make a garden that will ultimately become a source of delight, combined with a degree of common-sense utility (which is quite possible, in spite of limitations), one must be prepared to do an amount of merely preparatory work, which, to the uninitiated, seems almost superfluous.

Such operations as grading and draining, and even trenching and manuring, throughout the entire area, which are necessary to success, seem quite too formidable to the ordinary suburban householder, who does not consider the making of a mere villa garden a serious matter. His usual proceeding is to simply dig up the surface, plant all the favorite flowers of the family, without regard to suitability of soil or surroundings, water them occasionally, and leave the climate to do the rest, which it *does thoroughly*.

One reason, perhaps, why so many suburban gardens are a source of dissatisfaction to their owners is the want of accurate knowledge of the main essentials of making a garden, which people exclusively town-bred do not usually possess in the same instinctive degree as those who have passed their lives in rural districts.

The initial work of preparation is comparatively heavy, and takes much longer when a garden is already established than on an area where a house is first built.

The actual labour consists of—

I. Cleaning the area of all rubbish and burning it, and making a rough design.

II. Grading, trenching, and manuring, which can be made one operation.

III. Taking precise levels (all levels from highest points).

IV. Allotting land between the points.

V. Laying the drains where required.

VI. Making all necessary paths—main approach, side entrance, &c.

After these rules are carried out, the final design may be decided, after consideration of aspect, size of garden, position, and architecture of house.

No matter what design is ultimately adopted, the foundation work should be the same in nearly all cases, with this exception that the quantity of manure will vary according to the quality of the soil.

The best season to begin the preparatory work is early in autumn, in order to have manure thoroughly incorporated with the soil, and settled down in readiness for planting as much as possible during winter and early spring.

It is necessary to grade and trench the entire area, in order to make the soil of a uniform depth; trenching deepens the soil, and lasts practically for all time. The site for a villa is not determined by the horticultural properties of the soil, and in making a garden all deficiencies in that respect must be remedied by careful preparation.

Grading will equalize the soil so that scarcity of moisture and superabundance of heat in isolated portions of the garden may be done away with; in a garden composed of heaps and hollows the rain water would remain in puddles, become stagnant, and consequently sour the soil. Grading will facilitate the laying of drains, make all subsequent working operations easier to carry out, and add materially to the appearance of the garden when finished.

Manuring is generally required in suburban areas, to enrich and give body to the soil. The best soil for garden purposes is of a loamy character, deep, and friable. If not naturally of that description it can always be made up and improved—a close sour soil by the addition of lime and ashes, and heavy clay soil with sand, ashes, and lime. Thorough cultivation alone will improve any garden materially, but the general want in suburban areas, as elsewhere in Victoria, being humus, it follows that the addition of well-rotted stable manure or decayed vegetation, litter, &c., may all be worked in when trenching. (A general rule when cultivating is to allow twenty loads of manure to every acre.)

Air and water are as necessary to the development of plant as of animal life, and both air and water must circulate freely through the soil ; rain is fertilizing in its effects, but if it cannot pass freely through the soil the beneficial results will be lost to a very great extent.

Draining will only carry off excessive moisture, and not rob the land of what is required ; for, as land can only hold a certain amount of water, any excess will remain on top (to form a film excluding air) or run away.

Agricultural drain pipes are the best for this purpose, put in at a depth varying with the nature and form of the surface soil.

We should always endeavour to lay out a garden on a sensible plan, to allow of working with comfort and despatch, and place taps in such positions as to allow a hose to be uncoiled without injury to flower beds.

Though we may find it necessary to overhaul every corner in future seasonable work, it does not follow that a large number of paths are required. They are expensive to make and maintain and are not necessary for effect or as a means of reaching all parts of the garden. Curved paths are more attractive in appearance, and give the effect, when curves correspond in length and width, of greater space than an uncompromising straight line from entrace to house. An inexpensive path may be made of brick-bats, lime, rubble, and sand, which, if damped thoroughly before rolling, will make a hard, smooth durable path. The most effective flower-garden paths are of turf. Tar-paved walks throw the heat of the sun into the soil and dry it out.

When the heavy work is done, and the soil of a nice even tilth, the final design may be carried out. Villa gardens vary in size and shape, but there are several points that are helpful in all cases.

I. Any design should be in accordance with house, pocket, and comfort.

II. Mathematical designs and those characteristic of easy negligence should not be used in the same garden, as they produce an inartistic effect.

III. The relationship of house to garden and *vice versâ* must be observed.

IV. When planting a bed to be viewed from all sides, place the highest-growing plants in the centre, and graduate the others according to size.

V. Put strongest-growing plants in the coldest and wettest portion, and give open and best soils to those plants having the shortest life. Aspect is always of importance in the design; the house facing the south

protects the garden to a certain extent, and breaks the force of north winds, which are ruinous in their effects during summer. A southern aspect is favorable for summer, but coldest in winter. Summer conditions are the most trying, and in a garden having a northern aspect one should clothe the place as much as possible with high-growing hardy shrubs and creepers on the fence nearest the north ; always have a good background to shade the garden in summer.

VI. Avoid narrow borders, straight lines, fixed patterns. Grass borders should be 16 inches or 18 inches in width in order to retain moisture and for convenience when mowing. All narrow borders dry out and look mean.

If we desire our garden, when finished, to reflect nature in beauty and completeness, we must have sympathy with the plants we cultivate. To keep them healthy and in a state of active growth, we must give them the nourishment they require during the different seasons. We must not starve them during the early stage of their existence.

It is unreasonable to expect plants that have been neglected to build up a healthy organization and perfect flower and seed.

Individual tastes generally determine what shall be planted, but, to be successful in planting a garden, an accurate knowledge of various plants should be acquired, a knowledge of form, size, texture, period of flowering, and length of life.

Before planting, the plants to be employed should be carefully arranged. Two deciduous plants should not be put together, nor many of the same colour, size, or habit.

In making a lawn it should be put in wider than wanted, otherwise in summer it will fret, and in winter wash away. If made of buffalo grass, the best time for planting is from November to February. This grass may also be planted in winter and spring. To provide a quick-growing lawn of a vivid green, put in the young roots just starting in small pieces. Should large pieces of old buffalo be used the resulting growth will be weak. Allow the grass to grow irregularly over the edge and trim afterwards.

A plot of ground should be provided apart from the show garden to start seeds and cuttings, and a supply of pot plants kept on hand to fill up vacant places. Bulbs are also useful for this purpose.

It is impossible to give a long list of flowers suitable for villa gardens in this essay, but such established favorites as Camellias, or good varieties of Roses or Azaleas are suitable for the centre of flower plots, while Carnations, Bouvardias, and Heaths may blend with low-growing flowers such as Verbenas, Pansies, and

Petunias. For backgrounds and extensive borders Cannas, Dahlias, Helianthus, Cosmos, and Variegated Maize are most suitable, being hardy summer flowers.

Once established, a villa garden, in our trying climate, needs systematic attention. Each autumn it should be thoroughly overhauled. Recognise what is not necessary, take out exhausted and dead plants, and expose as large a surface as possible to the air. Stock should be raised or procured twice yearly, in order to provide for all seasons.

Everything should be done to deepen the soil. The right time for deep digging is in autumn or winter.

The lawns will require top-dressing in autumn, and mowing and weeding at intervals. Pruning will be necessary every year. The time is, in general, after the period of flowering is past. Shrubs should never be left for so long a period as to require harsh treatment. Pruning is necessary to keep plants within bounds, to quicken and rejuvenate the roots, to promote fine foliage and flower in abundance, to provide healthy and attractive form, and to let a proper degree of light into the soil. Prune hardwooded things in general when temperature is falling, and soft-wooded when the rigors of winter are past.

APPENDIX No. 3.

LEMON CULTURE.

(By Florence Jacomb and Marian W. Thompson, First Year Students.)

In selecting a site for the purpose of cultivating lemons in Victoria, one should be guided, in making a choice, by several definite properties of climate and soil, which are the two most important considerations, and should be in accordance with the special requirements of that particular fruit.

The climate in some parts of Victoria is exceedingly well adapted for growing the fruits that are brought to perfection in the south of Spain and France, and the low-lying valleys of Italy.

A warm climate and permanent supply of moisture are necessary. It is almost impossible to state the exact annual rainfall required, as conditions vary considerably in different parts of the colony. Choose a locality where the soil does not dry out, and where the spring rainfall will provide for summer exigencies.

The native home of the lemon is under the protection of other trees, therefore an extremely exposed situation would not be suitable. In summer the continuous hot sun would cause evaporation of moisture when most required, and cold winds in winter would have a perishing effect on all except the very hardiest trees.

The actual position of the orchard may be determined, partly, by the natural features of the country; the great desideratum being an area that is permanently enriched by surrounding influences, not impoverished by them.

Being an evergreen, continuously growing in a more or less active degree, the lemon makes heavy demands on the soil, which should be deep and of a permanent character.

A permanent soil consists of deep, turfy, friable loam over broken stone and gravel. The nature of the substratum is of importance. A dry heavy subsoil is bad, and wet and sour soils are to be avoided, as the roots are subject to disease. A deep comparatively poor soil is better than a rich shallow soil. The former can be improved by cultivation and the addition of manure, but a shallow soil is rich for a brief season only.

Gentle undulating surfaces and sloping country providing natural drainage are the best. Sloping country will reduce the labour of preparation considerably, by making grading easier, and facilitating the laying of drains if required.

A southern or sheltering aspect and fairly high elevation, 200 to 1,000 feet, should be selected. All lowland countries are too

LEVELLING AND GRADING LAND.

dry for citrus, without watering in summer, and more subject to frosts, unless on the sea-board, than high rolling lands, where atmospheric influences are more favorable.

Heavily-timbered country is generally good. Scrubby land is generally sour and poor. It is better to choose comparatively expensive land where there is permanent soil and moisture, provided it is within reasonable distance of a market, than to purchase cheap land which would require heavy working expenses in order to produce good crops of fruit.

Preparation of soil will vary according to area. Should forest land be chosen, all trees and roots must be grubbed out and burned on the ground. Plough and roughly grade, putting the worst soil at the bottom, then grade it precisely, plough again, clean off roots and rubbish, and then double-plough (have at least 10 inches of free soil), and harrow to obtain good tilth. The soil should be prepared in early autumn, and the opportunity should be taken to get rid of all impurities in the form of insects and fungi. Manure is not required in rich deep soil for young trees, but the addition of lime at this early stage, to sweeten the soil and dissipate any sour acids, would be of value.

Grading will equalize and improve the soil. In making an orchard it is necessary to grade and drain it in order to get good results. Heaps and hollows must be graded out. A portion of ungraded land in orchard holds an excessive amount of moisture, fouls the soil in winter, and makes it in summer unnaturally hard.

An area favoured with natural drainage can sometimes be obtained, but, if not, draining will be included in the preparation of the land. A system of drainage that will act perennially is required. Should the orchard be covered with water in winter, the soil will become foul and stifled for want of air. The object of getting rid of this excessive moisture is to obtain air, sweetness, and the proper degree of heat in the soil. After the preparation, the stations for trees should be pegged out at a distance of from 18 to 24 feet apart: regular planting secures an uninterrupted flow of air and light, and simplifies cultivation. The square system of planting is the best, it admits of ploughing eight different ways, and allows room for the development of each particular tree.

Maintaining the fertility of the soil can only be done by systematic and persistent cultivation, and by the addition of manure. We can maintain the fertility of the orchard by growing crops of legumes, and ploughing them in before they are perfectly matured, thus adding nitrogen and humus in an inexpensive manner.

In this country the ground is more impoverished if left open than when cropped; as the climatic influences are more deteriorating in their effects than are crops, and waste more of the food

supplies. We may grow vegetables in the orchard while the trees are young, to cover and shade the soil. All vegetables thrive best in generous deep soil, such as is required for cultivating the lemon. They could be grown alternately with the crop of legumes, until the trees attain maturity.

Stocks and Varieties.—The three best varieties for Victorian growers are the Variegated, Lisbon, and Villa Franca, the last-named being a very generous summer cropper, but requires more generous soil than the Lisbon. At the present time, stocks are being done away with throughout the colony and New South Wales, and layers are being used instead; but though these fruit earlier, and do very well in generous soils, they are not so hardy or long lived as budded trees on seedling stocks. Stocks worked on sweet orange, or own stock, may be used, providing they are healthy, with good circular root system. Budded stocks are best. There is greater vitality in any budded stock than in grafted, as the bud is younger and fresher than the piece of hardened wood which forms a graft.

Forming young trees.—The lemon is an umbrageous shrub, and should be trained as a bush, not a tree, its branches should come from near the ground. If trained as a tree, it will not be so profitable as when trained as a bush. The first necessity is a crop of wood ; very few heavy branches are required on a citrus tree, and they should be horizontal rather than upright, and trained to make a useful framework.

In forming the young lemon tree, if any of the young shoots are not in the right place, they should be taken off. This will cause the sap to be thrown down, and force shoots to grow in other places. It is not necessary to cut off the young shoots, as they may be removed by the fingers.

We prune the young lemon tree to distribute the wood, and get the tree into shape. All useless wood should be got rid of, and the weakly shoots cut out. The lemon tree grows twice a year. The heavy pruning in established trees is late in this colony, as it is on the extreme belt of citrus country. The lemon is branch-pruned, and it does not want too many branches; so it is best to cut away all the thin branches, and only to leave those that are strong enough, and are in the best position. The tree must not have direct exposure, nor must it be smothered; the weak wood should be cut out, the other thinned, and the shoots that have borne fruit cut back. The pruning of lemon trees extends over nearly all the year, the heavier pruning being done in August or September. If it were done earlier, while the weather was still cold, the wood would be hardened by exposure to the cold, and would not break and send out shoots, and the bark would die.

The thinning of the light wood in established trees can be done when they are carrying fruit. The pruning can also be done at the time of gathering the crop, the shoot being cut off with the fruit. This is the most economical way. In pruning, the whole of the shoot should be cut out. The points of the shoots should never be cut off, as that would cause the tree to grow too thick in the head, and promote growth where it is not wanted.

If it is necessary to take out intermediate branches, it should be done after the tree has borne fruit, when the heavy pruning is being done, and immediately after the crop has been gathered, as then there is no waste of energy, the sap being more or less at rest.

The light thinning out is done after the tree has borne its summer crop, and the heavier pruning after the winter crop. Excellent crops can be obtained from lemon trees without pruning, but only when they have plenty of water and exceptionally good soil. But if the tree suffers from want of water, it will require pruning, as it will make too much weak wood.

In the early winter, the soil round lemon trees should be protected by the lower branches. If a tree suffers from blight, it should be stripped of leaves and all light wood, leaving no branches less than an inch in diameter, then it should be covered with a paste made of 10 lbs. of clay, 1 lb. of sulphate of copper, and enough water to make it into a stiff paste. A canvas hood should be placed over the tree to protect the wood from the sun; a trench should be dug at the drip, as this is where the foraging roots are, then the roots should be cut, and manure and new soil given. This should be done in the winter. Lemon-growing in this colony may be considered one of the most profitable of the fruit-growing industries, as 2 acres of trees, from four to six years old, grown under favorable conditions, may be expected to give a return of £100 to £120 a year. Before that age they cannot be considered established trees, and of course the profits are less.

Lemons carry very well and are particularly adapted for export. They find a ready sale, either in the local or European markets. The expense of cultivating the orchard may be reduced by growing and marketing vegetable crops for the first four years. After that period the whole of the area will be required for the trees, and, in the summer months, the soil should be protected by mulch of well-rotted stable manure, or any litter that may be obtained conveniently and cheaply. The mulch should be put on in October, and removed in March. After the orchard area is prepared, and trees planted, the work is not heavy. The tree is not difficult to prune, and the seasonable work of a lemon orchard may be considered fairly light and easier to manage than orchards composed of deciduous fruit trees.

APPENDIX No. 4.

AN EXAMINATION PAPER.

(*By G. J. Wilmoth, First Year Student.*)

State (1) the bad and (2) the good influences of climate on soil.—1. Hot dry winds have a very bad effect on soil. The heat dries it, and wind carries away food-stuffs in the dust. Soils in damp cold climates are apt to become sour unless the cold is severe enough to cleanse them, which it is not here. Sudden changes are bad for vegetation. The sun draws up moisture, and bakes soil in places quite hard, so that roots cannot move and are pinched and wounded. 2. Warm moist climate has very good effect, as it means plenty of growth and a long growing season. Anything, given ordinary soil, will grow under these conditions. Frost is good for soil, as it breaks it up, and thus the food-stuffs are more easily got at.

State direct advantages from cultivating soil.—It makes food-stuffs available for plants by keeping the surface open, allows air and moisture to penetrate, breaks up capillaries in ground through which the sun draws up moisture, and thus keeps the ground more moist. By keeping ground friable, roots can move, and, in summer, surface cultivation makes a kind of mulch. The more the land is cultivated the less manure is necessary, as cultivation frees what food-stuffs there are.

What natural features should guide your selection of orchard and garden land?—Situation—whether near market, whether water and manure are available or easy to get, whether natural drainage or sufficient slope to drain with facility, not too great incline that water will wash ground to speak of; whether soil be deep (better to have deep and comparatively poor soil than good and shallow) and habitually moist. Also, the trees one wishes to grow would determine what kind of soil one wanted, or *vice versâ*. A southern slope is generally best in Victoria; the northern aspect is too hot in summer. Good natural soil is very much to be desired, as is also a spot sheltered from severe wind.

What means would you employ to free soil of injurious insects and fungi?—The ground should be cleared of all rubbish, and this should be burnt. Leave ground open some time before planting; light and air are great enemies to all kinds of fungi and blight. A light dressing of lime might be used if the ground is very dirty.

What are the good effects of drainage?—Drainage conserves moisture in summer and keeps soil drier in winter; it means that what water there is in the soil is kept moving, and it is when

PREPARING GROUND FOR VEGETABLES.

water is moving that it collects food and carries it to the plant. There being no surplus water lying about in winter, the ground is sweeter, more friable and acceptable to the roots of plants.

What determines the amount, frequency, and kind of manure necessary to any soil?—The kind of manure necessary depends on the nature of the soil. Light sandy soil needs heavy vegetable or farm-yard manure; close, clayey and damp soil wants manure that will open it and make it lighter. As a rule, one dressing a year is necessary, but the quantity contained in each dressing depends on the needs of the tree, the poverty or richness of the soil, and the quantity of water available (manure keeps the ground moister, so, the drier the soil, naturally the more manure it will need).

Which twelve fruits are most profitable to Victorian growers?—Pear, peach, apricot, plum, apple, lemon, raspberry, gooseberry, strawberry, grape, passion fruit, currant.

What point should guide you in selecting young trees?—The most imperative thing is a good root system—not too many fibrous roots, and some good leading ones. They should be evenly placed round the tree, as this means even growth in the head. The trunk should be smooth and straight, not too long—the shorter the better in a climate such as ours—and three, four, or five healthy branches at the head. We should regulate our choice by the situation in which the trees are to be planted—climate, soil, and aspect, as well as the amount of water and cultivation we can give them, being taken into consideration in selecting the variety. It is preferable to get trees that have been out of the ground as short a time as possible. As a general rule, budded trees are best; but if the situation is very good, and the soil very generous, pears that have been grafted—and even apricots—would be better than budded specimens. Another thing is the best stock. In hard or wet cold situations the stock should be thrifty and vigorous; strong-growing stocks not being used in very generous situations.

State the conditions under which (1) budded and (2) grafted trees should be employed.—Budded trees should always be used in any but the most generous soils and conditions, as the grafting has a dwarfing effect, and means poor growth, with that exception. Pears may be grafted, unless in hard situations, as this is such a vigorous, strong-growing tree. With short-growing seasons, wet damp soils in winter, dry situations in summer, or excessive heat or wind, budded trees should be used without exception.

Explain the advantages of design and equal vigour in fruit trees.—Equal size and vigour means equal growth and equal fruiting, which, in its turn, means easier management of trees and gathering of fruit. It also means less strain on the tree if it bears equally. The design allows light and air to reach every

part of the tree ; hence all the wood ripens and keeps fruitful. A thick head means bare, barren branches in the centre, and a narrow band of fruiting wood round the outside of the tree. A well-designed tree enjoys better health, fruits regularly, and lasts longer than an irregular specimen. Trees designed to be low and broad at the base shelter their own roots, and thus can stand the summer heat better.

What determines the size, shape, and internal structure of a tree ?—Various things, such as natural local conditions, cultivation, pruning, and variety of tree. The pruning for the first years builds up a good, strong, shapely head, more or less vigorous, according to variety of tree, stock, and whether budded or grafted. The deeper and better the soil and the more moisture it gets, the more vigorous the growth, and, of course, the pruning accords with the vigour of the tree—less vigorous, fewer branches and less work being allowed the tree. A tree with low horizontal branches—pyramid or dome shape—is good here, as it shelters its own roots and its fruit, and this is a great advantage in a warm climate. The internal structure depends almost entirely on the strength of wood required for fruiting.

What is the object of pruning during the first few years ?—The object of pruning during the first fewyears is to train the tree to a good shape, the branches even in quality and evenly distributed, not so close as to prevent light and air reaching every part of the tree, and not too many of them, to make each one small and weak—four or five small branches are generally enough. The pruning at this time is all for wood, as if the young tree were allowed to fruit—even if inclined to do so—the wood would be hardened, and the tree weakened, and short-lived. The first object to be attained at this stage is a strong, shapely tree, with a good root system, on which the only strain should be that of producing a strong, shapely head.

How would you preserve a full supply of fruiting wood on the lower portions of established trees ?—Keep the top light, and throw back the sap by free cutting of top, letting in light at the same time. This will flood the lower branches, and by doing so every season, the entire tree may be kept fruitful. All weak and useless wood must be cut away every year, to induce strong buds to break.

Give some reasons for barrenness or irregular fruiting.—May be growing too strong to fruit, or may not be strong enough ; may be through starvation, or want of water (which means the same thing). The trees may be seedlings, and seedlings are always uncertain in fruiting. The fruit may not set, the flowers may not be pollenated ; may be due to our soil, the result of imperfect cultivating. This is one of the most common causes of unfruitfulness.

Name and give age of fruiting wood in apple, peach, and apricot.—Apple bears on wood two seasons old (except when wood made previous season has been spurred in autumn) and then on the same spurs two, three, or four years, according to strength of wood. Apples bear on spurs only, either natural or artificial. Peach bears on natural shoots and natural spurs of last season's growth only. Apricot bears on natural shoots and spurs, and of last season's growth, and then on the same spurs for two, three, or four years, as the wood is strong or otherwise, and on artificial spurs, so long as they are strong and healthy.

What enables one to decide on the most favorable season for pruning various shrubs ?—It depends partly on the situation and climate. In cold, exposed places it is left later than under generous conditions and warmer situations. Pruning is always done just after the time of flowering or of greatest beauty (if not flowering shrubs). It should not be done early enough to encourage growths that will be cut by late frosts. In case of shrubs pruned in winter, these will be hard-wooded. Soft-wooded shrubs are almost invariably pruned in spring ; these should be pruned early enough for buds to get a good start before the hot weather sets in. Also it depends upon the vigour of plant and quantity of flowers. If too strong to flower well, late pruning will generally throw it into flower, on account of the check received.

What governs the arrangement of plants in a villa garden ?—Soil, aspect, water, and cultivation available, and plants at one's disposal. Tallest shrubs are placed at highest points, and never in front of smaller plants. The hardier plants should be placed in the poorest and most exposed situations, and *vice versâ*. One always takes one's point of view from the main entrance, and regulates the planting accordingly. Always plant so that the effect increases the apparent size of the area at one's command. Plants that are similar should never be placed side by side, and they should always be so arranged as that there is never a bare part here and one looking very full there. Masses always give better effect than plants placed singly.

Arrange these subjects in the order in which they should be taken on a new garden area : Trenching, grading, draining, designing, manuring, cleaning.—Clearing, grading, trenching and manuring, draining, designing.

Why do cuttings strike more readily in pots than in the open ground ?—They get more moist heat than in the open—the heat of the pot draws the sap down, and encourages rooting. The soil used—sand, sandy or peaty loam—is sweeter and more favorable than general garden soil. Some cuttings touch the bottom of the pot ; this, as said before, draws the sap down ; and it is for the same reason that the cuttings nearest the edge of the pot root more readily than those nearest the centre. Also, the cuttings are more sheltered, and not subjected to extremes of temperature.

Why do we water trees and plants before transplanting them ?—The water keeps the air away from the roots when they are being moved—they have also benefited by the nourishment, but the chief reason is that the damp soil kept round the plant excludes the air, and it prevents injury to the roots. It also makes it so much easier to take up a ball of earth with the plant.

Which are the most favorable seasons for overhauling beds and borders and carrying out reforms in the soil ?—Spring and autumn, the latter in particular ; all big alterations and reform should be carried out in the autumn, and the plants should be manured when most inactive, generally late autumn and winter. Mulching should be done in late spring or early autumn, before the ground gets dry, and after it has quite recovered from low temperature—mulching then has the effect of vapour bath for roots, and prevents growth receiving check by ground drying out.

What natural features enable one to supply the right class of manure to various plants ?—It depends on the nature of the soil and of the plant. Gross feeders will take ranker manure than others. Some can only stand manure that is thoroughly spent. These are in the great majority. If the plant be growing too vigorously to flower and fruit, it needs little or no dressing ; a weakly tree needs plenty of good well-spent manure. Some plants will stand more than others, and, apart from the general fact that the shorter-lived the plant the more it needs, this must be decided by experience. The heavier the soil, the more opening the manure used must be ; ashes, lime, &c., being splendid for heavy soil, but lime must be used with great care. Heavy soil, as a rule, needs working as much as manure, but light soil needs any quantity of manure. The drier the soil the more manure it requires—manure conserves the moisture so much in summer. Also, the drier the soil, the more waste from the elements and the more food to be replaced. Again on a slope, water carries much food away, and all this must be made up to the plants. Manure should never be dug in near the trunk, it encourages small roots, but just outside the roots, so that they may be encouraged to move. Practically, the best all-round manure is well-spent stable manure.

What necessary property is most rare in the dry and warm Victorian soils ?—Humus.

Which are the most favorable seasons for raising young stock in the open air ?—For apple root grafts, late winter ; for cuttings, early winter and late autumn ; for seeds, late summer, autumn, and spring. Class of soil: Sandy loam, over ironstone or limestone, or with gravel beneath, fairly moist naturally, as irrigation does not at all improve grapes—rather spoils them, in fact, making them too watery. Site: On slight slope, not exposed to wind, as this hardens the skin, not higher than 1,000 feet above sea-level. Class of wood for cuttings : Take, if possible, with small foot, as

the buds at base make roots quicker than those higher up. Select wood of previous season, fairly strong, but not late or water growth. Heavier and colder soil, more slanting, plant the cutting. Plant with only two buds above ground.

When are all kinds of plants most liable to attacks from insects and disease?—Most liable to attack when not growing freely. Therefore, poor growth and checks should be avoided. Different insects are worst at different times—red spider in dry warm weather, aphis in warm moist weather, scale at any time—with pear slug, borer and codlin moth; health of tree makes little difference. Pests are generally most active in spring, and best time for treatment is after pruning, and when the tree starts to grow in spring and early summer.

What kind of vegetables and flowers are able to thrive in rank unfermented manure?—Very few. Cabbage, cauliflower, gourds, certain root crops and a few annuals, only exceedingly quick-growing things; all quick-growing plants will thrive with any quantity of fermented manure, but few can stand it unfermented.

State briefly the essentials to success in vegetable culture.—Good rich soil, water, good drainage, cultivation, quick growth with no check whatever, market easily available.

Name six vegetables profitable on a small area, and seasons at which they are marketable.—Asparagus, in the spring and summer; highest value in spring. Tomato: Best price when very early or very late, in season summer and autumn: tree tomato in spring as well. Cabbage: Winter and autumn. Cauliflower: Summer and early winter. Brussels sprouts: Same as cabbage. Pea: Early summer.

State seasons at which different classes of pruning are carried out in citrus trees.—The following answer is taken from the examination paper of Mrs. J. McWilliam:—"All heavy pruning of citrus trees should be done in winter, after the removal of crop, which generally can be gathered at midwinter. If there has been no winter crop, prune as soon as cold weather sets in. Also cut away the tiny shoot that has actually borne the fruit; never tip citrus. These tiny shoots are best removed by cutting the fruit instead of pulling it off when gathering crop. Young citrus do not require much pruning, as they will be replaced by the strong shoots which come away at base, and afterwards form permanent tree, then original growth may be cut away. During spring citrus trees require thinning and spacing to let in air and light, about 18 inches apart for shoots. If trees are dormant and making no growth, cut off all twigs and shoots, and prune hard, then protect with canvas; shield from sun. On the top will do, but, better still, if canvas hood reaches ground; then spray and vapour caused thereby promotes growth."

APPENDIX No. 5.

SELECT LIST OF TWELVE LEADING FRUITS SUITABLE FOR LOCAL AND EXPORT MARKETS.

Twelve Good Pears.

1. Williams' Bon Chrêtien ; February.
2. Beurré Capiaumont ; February and March.
3. Louise Bonne de Jersey ; March.
4. St. Michael Archangel ; April.
5. Beurre Clairgeau ; May and June.
6. Doyenne du Comice ; June and July.
7. Vicar of Winkfield ; June and July.
8. Eyewood ; June to August.
9. Josephine de Malines ; July and August.
10. Winter Nelis ; July and August.
11. Easter Beurré ; August and September.
12. L'Inconnue ; August to October.

Twelve Good Plums.

1. Early Orleans ; December.
2. De Montfort ; December and January.
3. Prince Englebert ; January.
4. October Gage ; January.
5. Diamond ; January.
6. Washington ; January.
7. Kirk's ; February.
8. Angelina Burdett ; February.
9. Yellow Magnum Bonum ; February.
10. Fellenberg ; February and March.
11. Pond's Seedling ; March.
12. Ickworth's Imperatrice ; March.

Six Prune Plums.

1. Prince Englebert.
2. De Montfort.
3. Angelina Burdett.
4. Fellenberg.
5. French Prune.
6. Diamond.

Twelve Good Apples.

1. Jonathan ; March.
2. Rome Beauty ; May to July.
3. London Pippin ; April to June.

A LESSON IN DESIGNING FRUIT TREES.

4. Prince Bismarck ; March and April.
5. Munro's Favorite ; June to August.
6. Esopus Spitzenberg ; June to August.
7. Rymer ; August to October.
8. Reinette de Canada ; March to May.
9. Stone Pippin ; August to November.
10. Scarlet Nonpareil ; July to October.
11. Cleopatra ; August to October.
12. Shepherd's Perfection ; May and June.

Six Good Apricots.

In order of Ripening.

1. Oullin's Early.
2. Kaisha.
3. Alsace.*
4. Hemskirke.*
5. Mansfield Seedling.
6. Moorpark.*

Four Almonds.

1. Paper Shell.
2. Brande's Jordan.
3. I.X.L.
4. Nonpareil.

Twelve Good Peaches.

Arranged in order of Ripening.

1. Alexander's Early.
2. Briggs' Red May.
3. Downing.
4. Early Rivers.
5. Hales' Early.
6. Royal George.
7. Duke of Edinburgh.
8. Merchant Campbell.
9. Lady Palmerston.
10. Salway (or Mixon Free).
11. Susquehanna.
12. Whatmough's March.

Six Gooseberries.

1. Billy Dean (red)
2. Crown Bob (red).
3. Roaring Lion (red).
4. Leveller (yellow).
5. Waterloo (white).
6. Lord Crewe (green).

* Suitable for drying and canning.

Six Raspberries

1. Belle de Fontenay.
2. Rivers' Monthly.
3. Fastolf.
4. Wandin.
5. Semper Fidelis.
6. Northumberland Fillbasket.

Six Strawberries

1. Edith Christy.
2. La Marguerite.
3. A. F. Barron.
4. Laxton's Monarch.
5. Latest of All.
6. Trollope's Victoria.

Six Currants.

1. Carter's Black Champion.
2. Lee's Prolific (black).
3. White Imperial.
4. White Dutch.
5. La Versaillaise (red).
6. La Hâtive (red).

Twelve Cherries.

Arranged in order of Ripening

1. Early Purple Guigne.
2. Bigarreau Twyford.
3. „ Rockport.
4. Knight's Early Black.
5. White Heart.
6. Bedford Prolific.
7. Black Tartarian.
8. May Duke.
9. Bigarreau Napoleon.
10. „ de Hollande.
11. Florence.
12. St. Margaret's.

Three Lemons.

1. Villa Franca (summer fruiting).
2. Lisbon.
3. Lisbon Variegated.

By Authority: Robt. S. Brain, Government Printer, Melbourne.

With Compliments from Translators.

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DEPARTMENT OF AGRICULTURE.

VITICULTURAL STATION, RUTHERGLEN, VICTORIA.

TRENCHING AND SUBSOILING

FOR

AMERICAN VINES.

Compiled and Translated from European Authorities by

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TRANSLATORS' PREFACE.

In a retrospective survey of the early history of the reconstitution of French phylloxera-devastated vineyards on American resistant stocks, no feature is more conspicuous than the numerous disastrous failures recorded. These failures arose from very varied causes, among others, almost complete ignorance as to the classes of soil in which the American vines grew naturally, want of practical information with regard to their grafting affinity with European vines, uncertainty in respect to the varieties and even species planted, their doubtful resistance and occasional negative immunity to strong attacks of phylloxera, and, finally, adherence to the old methods of shallow preparatory cultivation in creating the new vineyards.

It is well known that these first failures of some 30 years ago in France, caused very heavy financial losses to viticulturists, but, their secondary effect amply compensated the losses, for thorough studies were forced to be undertaken on exact lines to ascertain the causes of the failures, and, the true explanations being arrived at, vine-growers, wary of the former object lesson and benefited by increased knowledge, were able to triumph over every obstacle, and eventually reconstitute their vineyards under extremely varied conditions, with the fullest measure of permanence, and success.

The primary object of the present compilation is to place before those Victorian vine-growers, who have been so unfortunate as to find their vineyards already destroyed, through the irresistible progress of the phylloxera, detailed descriptions of the practical working methods and implements now

used in Europe, for overcoming one of the causes responsible in no small measure for numerous former failures in reconstitution with American vines, namely, ignoring the necessity for preparatory deep cultivation before planting out. At the same time, those growers not yet invaded would do well to prepare for the inevitable, as, ultimately, judging by European experience, the infection and destruction of all our vineyards by the phylloxera may be accepted as a certainty, being simply a question of time; every vine-grower, therefore, should feel compelled to study the ways and means for permanent reconstitution.

The practical experience of European viticulturists proves incontestably, that successful reconstitution on American vines, necessitates far deeper preliminary disturbance of the soil than that required ordinarily by European vines,* owing partly to radical differences in their root structure and underground development, but, principally, to the fact that phylloxera living on them is only prevented from inflicting serious harm through their more or less resistant and luxuriant root growth. This shows how essential thorough and deep preparatory cultivation of the ground is, in order that the recuperative root system may freely expand, without check or hindrance, so as to obtain the utmost benefit from the resistant stock, and enable it to increase in diameter at the same rate as the scion, for it is well known that most American stock actually used for reconstitution do not develop in diameter at the same rate as the *Vitis Vinifera* scion, without this essential preliminary of deep cultivation. This is now so definitely accepted throughout

* The advantages of deep cultivation, in the case of V. Vinifera, was recognised by the ancients. In the works of the Roman philosopher, Columella, *Rei Rusticæ Scriptores*, written early in the first century, during the reign of the Emperor Claudius I., the following very clear and precise passage on trenching occurs in Lib. III., sec. XIII.: "The soil of the plains should be disturbed to a depth of 1½ feet, hilly soils to a depth of 3 feet, and steeper hills to a depth of 4 feet, for, if the bed of soil ploughed with the *pastinum* is not made much deeper than is usually done on flat lands, the soil falling down from the top towards the bottom would leave a quantity of arable ground barely sufficient to allow it to be ploughed with the *pastinum*."

European vine-growing countries that it would be exceedingly unwise, and undoubtedly financially disastrous, to disregard this first essential condition, *i.e.*, *preparatory deep cultivation*, if we desire to assure the success and permanence of reconstituted vineyards in Victoria.

We do not consider it necessary to quote extensively from European authorities in support of this well-established and incontrovertible fact, but the opinion of Professor Pierre Viala, Inspector-General of Viticulture for France, and L. Ravaz, Professor of Viticulture at the National School of Agriculture, Montpellier,* as given in their work on American vines, may be accepted as unquestionably authoritative and representative; it is based on extensive practical experience and scientific study of the question, for principally under Professor Viala's direction, France has permanently reconstituted nearly 2,000,000 acres of phylloxera-devastated vineyards, embracing almost every class of soil :—

"*Deep Cultivation.*—The vine, like all plants, prefers a deeply loosened soil. Trenching or subsoiling is therefore necessary, and, if not indispensable (for all American vines can grow in untrenched ground), is at least of great utility for such varieties as the Riparia, most of the Rupestris, &c., which grow very slowly in compact soils. Trenching or subsoiling, however, obtains in many vine-growing regions for the varieties of the V. Vinifera, and in many places not a single vine is planted without previously trenching or subsoiling the ground to a depth of 20 inches, or even 3 feet.

"The vine grows more vigorously during the first years in trenched ground, and bears fruit at the third leaf, while in non-trenched ground it does not bear crops till the fifth or sixth year ; an advantage of two or three good crops is thus

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* Viala and Ravaz. *Les Vignes Américaines, Adaptation, Culture, Greffage, Pepinières.* 2nd ed. Paris, 1896.

derived. It is always important to gather a crop as soon as possible, to cover the considerable expenses incurred in planting a vineyard; trenching, therefore, is more than ever necessary; it hastens the growth of the vine, and places it in better conditions for its future development.

"It is especially necessary for grafted rootlings. These young plants, often weakly at the time of planting, and with a root system always weaker than that of ordinary rootlings, usually remain sickly when planted in soils which are not favorable; thorough trenching greatly facilitates their early growth.

"Generally, trenching to a depth of about 20 inches is sufficient for American vines; a greater depth, however, suits them better. It may be done either by hand or plough. If in both cases the soil is not very calcareous, the subsoil should be brought to the surface, where it improves by contact with the air and under the action of successive manurings, thus augmenting the layer of arable soil. Further, as this is devoid of grass seeds, the vineyard may be easily kept free from weeds for several years.

"On the other hand, in calcareous soils, or when the subsoil is very calcareous, the latter must not be brought to the surface, or even mixed with the arable soil. We all know that carbonate of lime is detrimental to the vine, consequently, it is useless to mix it with the arable clay-siliceous or other soils in which the roots grow well, or even to place it on the surface, where the rain would carry it to the roots. Such a trenching would cause the leaves to turn yellow, and consequently prove its harmful effect. It is better in such cases to *subsoil*.

"Trenching, or subsoiling, under suitable conditions frequently removes the excess of water from damp soils, diminishes their coldness, and renders assimilable the matters which otherwise could not have been utilized by the vines."

More recently, Professor G. Foëx, Director of the National School of Agriculture, Montpellier, has expressed the following decisive opinions* :—

"Soils in which American vines are to be planted must be prepared with great care. From the different facts already mentioned in this book it results that with regard to adaptation to soil the greatest obstacle is, on the one hand, excessive moisture in winter and the cooling of the soil resulting from it, and on the other hand considerable loss of water through evaporation in dry summers. The best and only remedy for these two inconveniences is deep and thorough trenching. As a matter of fact, if the excess of water percolates easily through well-divided soil, it also remains longer under these circumstances, for the capillary attraction drawing it towards the surface where it evaporates is less felt than in compact soils. Finally the roots penetrate deeper and find better surroundings in soils deeply disturbed.

"*Depth of Trenching.*—Trenching previous to planting is therefore essential, but the depth of this cultural operation naturally varies with the nature of the soil. Soils naturally dry and poor must be disturbed deeper than fresh and fertile soils. In the first case the depth should be 24 inches, while in the second 16 or 20 inches might be sufficient. However, if the arable soil is shallow and rests on permeable limestone subsoil the latter should not be disturbed, for the roots can naturally penetrate it and get sheltered against drought.

"*Trenching must be done much deeper when a new vineyard is planted on the site of the old vineyard immediately after it has been uprooted. This is generally the case with American vines. Under these circumstances, a depth of* 30 *to* 32 *inches is required.*"

It has been urged against the hard-earned and costly experience of European viticulturists, which prove the impossibility of permanent reconstitution without previous deep

* G. Foëx, *Manuel Pratique de Viticulture pour la reconstitution des Vignobles meridionaux.* 6th ed. Montpellier, 1899.

cultivation, that those requirements do not apply to Victorian vineyards, the assertion most frequently advanced being that our vineyard soils do not require such deep cultivation as is necessitated in Europe for reconstitution. In other words, that our vineyard soils are naturally better suited to the vine without deep cultivation than those of France, Germany, Austria-Hungary, Switzerland,* Italy, Roumania,† and other European countries, where deep cultivation is accepted as an essential preliminary in planting American vines, and, therefore, that our usual procedure of shallow cultivation is ample. We have no hesitation in condemning this fallacy, as the assertion does not tally with the poor average yield of Victorian vineyards, or with the frequent occurrence of *pourridié* (a cryptogamic disease, attacking both European and American vines, for which no direct remedy is known at present).

Other viticultural countries, besides European, have blundered over the preliminary preparation of the ground for American stocks, notably California, in quite recent years, where vine-growers confidently ignored previous European experience. We would do well to profit by the Californian failures. Judging by some of the opinions expressed adverse to deep cultivation for American vines the exercise of a little discretion and common sense will save some of our local vine-growers, about to reconstitute, from a repetition of

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* The reconstitution of vineyards in Switzerland with American stocks was sanctioned by the Swiss Government in 1896 (*Rapport de la Commission administrative sur l'exercice 1895. Neuchâtel*, 1896), in consequence of the very limited success of the costly annual treatments involved in the attempts at extinction of the phylloxera.

The first Swiss State nursery of American vines was established at Auvernier as far back as 1889. There are now State nurseries for the propagation of American stock in almost every canton. These nurseries occupy over 15 acres. The area of Swiss reconstituted vineyards is increasing rapidly every year. (J. Dufour, *Les Vignes Américaines et la Situation Phylloxérique dans le Canton de Vaud.* Lausanne, 1899.)

† G. N. Nicoleanu, *La lutte contre le phylloxéra en Romanie.* Bucarest. 1900.

the disasters recorded by A. P. Hayne, Director of Viticulture for California.* We extract the following from Hayne's work on Resistant Vines:—

"*Cause of Failures.*—Another cause of failure in soils that to all appearances are 'Riparia soils,' is that the land was not in proper condition when the stocks were planted. It has already been remarked that the resistant vines require far greater care in planting than is usually given to the Vinifera. The most important point is the proper preparation of the soil before planting. It has been established beyond the possibility of rational doubt that, before planting American vines, the land should be given one ploughing that is twice as deep as would have been necessary had Viniferas been planted in the usual manner. This is one of the practical lessons learned abroad. One of the vineyards that is used by the Professors of the National School of Agriculture in France as the most striking illustration of the necessity of deep planting, is situated on the banks of the River Hérault, on the very best "Riparia soil" in France. When first planted in resistant stocks no deeper ploughing than had been given for the Viniferas was thought necessary. A very large vineyard was planted with Riparias. After several years it was found that they seemed to be total failures. As the soil was a typical Riparia soil, and the variety used was the very best, much interest was aroused. After consultation it was decided to dig out the entire vineyard, give it a very deep ploughing, and replant it with cuttings from the same mother vines that had supplied the cuttings for the original plantation. This was done, and to-day there is not a finer vineyard in the district. Experience has shown that all American resistants require deep ploughing at first, though some do not require quite as deep preparation as others. The Riparias are the most exacting in this respect. It is a safe rule to follow, that the drier and

* A. P. Hayne, *Resistant Vines: their Selection, Adaptation, and Grafting.* University of California, Sacramento, 1897.

poorer the soil the greater the care should be taken to prepare it for the reception of American resistant vines.

"*Preparation of the Ground.*—Here, again, attention must be called to a fact that has been well established the world over, namely, that all American vines must have deeper and better cultivation in starting than the Vitis Vinifera or European vine. This is not a theory, but a fact too well established under the greatest variety of conditions to be controverted. There are in this state some striking examples of the good effect of extra-deep ploughing before planting out American vines.

"Too great stress cannot be laid on this necessity of deep preparatory ploughing. Especially is this necessary in California on lands that, while not being especially dry, are apt to dry down considerably in summer. It is especially necessary with the Riparias and those resistant vines that tend to throw out their roots horizontally, instead of downward, as in the case of the Rupestris. But even the Rupestris requires deep ploughing to give it a good start. Professor Viala says that very deep ploughing of land destined to be planted in American vines will advance crop-bearing from one to two years; and the facts certainly bear out this statement. Those who cannot give their vineyard land a ploughing twice as deep as is usually given, no matter what be the fertility of the soil, are advised not to plant American vines, for they will surely lose the money invested.

"The soil should be ploughed at least once, with a four-horse sulky plough, as deep as the plough can be driven—even if a couple of extra horses have to be called in to pull it. It is, of course, an expensive operation, but it pays, and pays well, to incur it. As before remarked, land thus prepared will yield paying crops two years sooner than if the ordinary method of ploughing be pursued, besides avoiding the risk of the loss of the entire vineyard. The poorer the

land the deeper it should be ploughed, and the more compact the land the deeper it should be ploughed."

According to F. T. Bioletti, of the Viticultural Department, University of California,* "In some of the loose, deep, rich soils of California, such deep subsoiling as recommended by Viala is unnecessary. In other soils, however, it has been found very advantageous to subsoil deeply, especially in somewhat exhausted land, or that in which a "plough-sole" has been formed by years of shallow ploughing. There are very few cases in California where deep subsoiling is a disadvantage, as our top soils are, as a rule, fairly deep. In some soils, however, which are very stony, deep subsoiling is impracticable, and in other soils where a stiff, raw clay is but a short distance from the surface it may sometimes be harmful."

There is another important feature in deep cultivation of vineyards, namely, the removal of stagnant or excessive water, as well as the roots of Eucalypts, &c., which are generally left to decay *in situ*. When an excess of water is present in a soil, the internal channels being choked, prevent the access of the necessary amount of oxygen, on which the activity of the soil, considered as a laboratory for the elaboration of plant food largely depends. Again, when trees have been badly grubbed, and roots left in the soil,† the mycelium of different fungi [*Dermatophora necatrix* (R. Hartig.), *Agaricus melleus* (L.) or *Armillaria Mellea* (Vahl.), *Rœsleria hypogæa* (Thum. and Pass.)] develop rapidly, especially in

* Communicated to us. September, 1900 [R. Dubois].

† Palladius (370, 395 A.D.), a Latin author, describes trenching in his work on Agriculture, Book II., section X, and refers to the removal of roots. "The time has now arrived for working the land intended for vines with the *pastinum*. This may be done in different ways, by disturbing the whole surface, by making trenches, or by forming pits. The soil should be wholly turned over, *so as to remove stumps, roots of ferns, and other detrimental plants.*" Palladius was a noted plagiarist; it is supposed that his agricultural methods were largely borrowed from Magon, of Carthage, who wrote an Encyclopædia of Agriculture in 22 volumes, 540 B.C. When Carthage was conquered by the Romans, the Roman senate ordered this great rural encyclopædia to be translated for the benefit of Roman agriculturists.

damp clayey or marly soils with an impermeable subsoil. This fungus growth soon gains the roots of vines, developing on them, and occasioning a disease known as *pourridié*. The effects of this disease are as disastrous as those of phylloxera, for it finally results, in soils favorable to its development, in the death of the vine attacked. It accounts in a measure for the small yield of Victorian as compared with reconstituted deeply-cultivated European vineyards. As we have already remarked, no specific remedy or treatment for it is known. Probably many vine-growers are familiar with this disease, as its white mycelium filaments are easily detected by the eye, and are readily distinguishable by their decided mushroom odour. It exists in a more or less acute form in almost all the vine-growing districts of Victoria. Its appearance can only be attributed to excess of water in the soil, together with old decaying roots in the subsoil. This has been very clearly proved by investigations made by Rochemache* in connexion with the cause of failures in vineyards planted in cleared ground, trenched to a depth of 16 inches; the trenching had not been deep enough to remove all roots, which, consequently, acted as sources of the fungi from which the contagion originated, and, in conjunction with stagnant water, formed veritable hot-beds of infection by *pourridié*.

To sum up, it is an essential condition, if we desire to insure permanence and success with American stocks, to disturb the soil deeply, for the following reasons :—

1st. To enable their root system to expand freely, in order to assure the stock developing at the same rate as the scion, and, consequently, success in grafting and profitable yield.

2nd. To allow access of air to the subsoil, chemically essential to the elaboration of the substances necessary for the nutrition of vines.

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* *Revue de Viticulture*, 1899.

3rd. To remove stagnant or excessive water.

4th. To extract all roots. The two latter conditions being imperative to prevent the appearance of *pourridié*, and therefore a diminution in the grape yield.

The principal local objections urged against preparatory deep cultivation are :—

1st. The proper implements and knowledge of methods are not obtainable in Victoria.

2nd. The work is too expensive.

The object of the present compilation is to answer the first of these objections, by describing in detail the methods, machinery, and implements used in European vine-growing countries, giving their cost when available ; and to show that deep cultivation is possible by using large heavy ploughs hauled by winding-drums worked either by horse or steam power.

In answer to the second objection we urge co-operation in the purchase of the necessary machinery or implements. If a few neighbouring vine-growers unite and purchase these in common, the outlay will be divided between several persons, and, as the operations will extend over a greater number of days per year, the cost of cultivation will be reduced proportionately, and will not be found to exceed that now paid for ploughing 12 or 14 inches deep. Further, when the trenching or subsoiling operation is finished, the plant may be used for ordinary ploughing, harrowing, scarifying, rolling of vineyards, as pointed out by A. Debains (see page 135).

In conclusion, we quote the pregnant words of Professor B. Chauzit*—

"Great importance must be attached to the trenching or subsoiling of vineyards; the future of the vine is entirely dependent on this operation. Reconstitution on American

* *Revue de Viticulture*, 21st October, 1899.

stock becomes rapid, the vines bear heavily and much earlier in well-trenched ground, on the contrary, in shallow trenched ground of from 10 to 14 inches, for instance, American vines develop very slowly and are unproductive. We cannot therefore take too great care in the thorough performance of trenching. It is the basis of the successful establishment of a vineyard. If in the beginning expenses are curtailed, the future of the vineyard is compromised. To economize in deep cultivation is to forestall failure before having even started the viticultural work on which one depends."

RAYMOND DUBOIS.
W. PERCY WILKINSON.

Viticultural Station,
Rutherglen, November, 1900.

I.

TRENCHING AND SUBSOILING FOR AMERICAN VINES.*

By P. Ferrouillat,
Director of the National School of Agriculture, Montpellier.

WHIM, OR HORSE-GIN.

Under the name of *whim*, *horse-gin*, or *winding drum*,† we understand a simple machine frequently used to overcome a great *resistance* with a very small *motive power*. Fig. 1 is a *windlass* commonly used for raising water from a well. It consists of a drum or cylinder A A′ of wood or metal, at both extremities of which are axle-trees

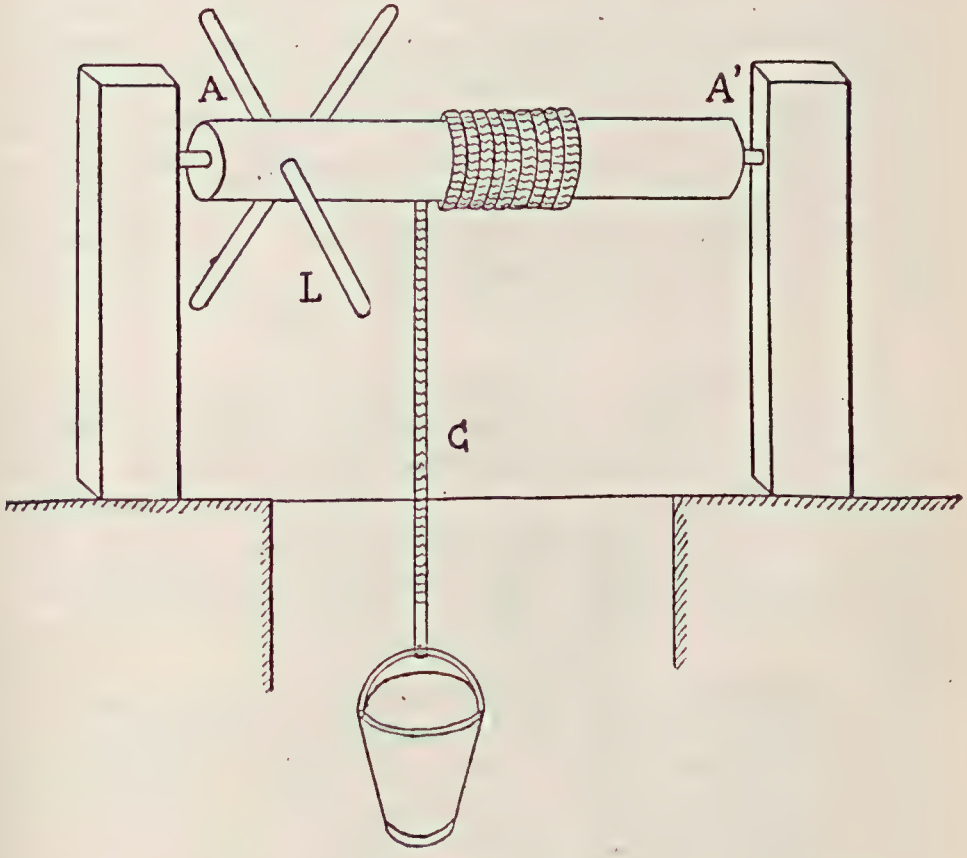

Fig. 1.—Ordinary Windlass.

* *Le Progrès Agricole et Viticole.* Vol. 15. 1891.

† These words are used as equivalent to the French "*treuil.*" Horse-gin, according to Webster's Dictionary, 1899, is a contraction of horse-engine. (Trans.)

revolving in two sockets. Levers L are fixed through the cylinder, and it is by acting on these levers that *power* is applied.

A rope or cable C wound on the drum, supports a bucket, the weight of which is the *resistance* to be overcome. The friction of the axle-trees and the rigidity of the rope not being taken into consideration,

P, being the effort exerted tangentially at the extremity of the lever L.

l, the length of the lever, measured from the axis of the cylinder.

Q, the weight to be raised, or the *resistance*.

r, the radius of the cylinder around which the rope is wound; it is shown in mechanics that—

$$\frac{P}{Q} = \frac{r}{l}, \text{ or } P = Q \times \frac{r}{l};$$

that is to say, that the motive power is to the resistance as the radius of the cylinder is to the length of the lever, or, in other words, that the motive power is a fraction of the resistance equal to the ratio between the radius of the cylinder and the length of the lever. The smaller r is in relation to to l, the greater Q may be in relation to P. If for instance,

$$\frac{r}{l} = \frac{1}{10},$$

we may, with an effort of 10 lbs. raise a weight of 100 lbs. Practically, we must take into account the friction of the axle-trees and the rigidity of the rope, so that the useful resistance Q′ overcome by the windlass, is a little less than Q, which, theoretically, is in *equilibrium* with P. We will see the importance of these *passive resistances*, also called *detrimental forces*, in the machines we are going to study.

In mechanics *we always lose in velocity what is gained in force*, and reciprocally. If the windlass equilibrates a great resistance by a small motive power, it is only at the expense of the velocity or rate. We see that the path traversed at each revolution of the windlass by the moving power is equal to $2 \pi l$; that traversed by the resistance is $2 \pi r$. These two paths traversed in the same lapse of time are, therefore, in inverse ratio of the effort developed to the resistance overcome. We may, with a moving force of 10 lbs. raise 100 lbs., provided r be $\frac{1}{10}$ of l, but the weight,

Q, will travel ten times slower than if the force P, was applied directly with the same velocity; or, what is the same, it will take ten times longer to raise the weight.

The windlass arranged as shown in Fig. 1 may also serve to raise loads. It forms the essential part of the machine known as the *lifting crab*, which is used in building to raise stones and timbers. The lever *l* may be replaced by a winch-handle made fast to one of the axle-trees passing through a socket. In the quarry windlass a large wheel of 13 to 19 feet in diameter replaces the levers. It is provided with bars. Men mount these bars as if on a ladder, and it is their weight which constitutes the moving power.

If the axis of the windlass is vertical instead of horizontal, and if, therefore, the levers rotate in a horizontal plane, the machine takes the name of *capstan*. The conditions of equilibrium are evidently the same. Under this form the capstan is sometimes used in cellars to work wine-presses; the rope is fixed on the bar of the press, and men work the winding drum of the capstan with capstan bars.

To attain still greater traction, toothed wheel gearing may be interposed between the motive power and the resistance. Fig. 2 shows diagrammatically the toothed-wheel gearing. The drum *t* carries a toothed wheel R′ geared with a pinion *r′*. On the shaft of this pinion a toothed wheel R is fixed gearing with a pinion *r*, on the shaft of

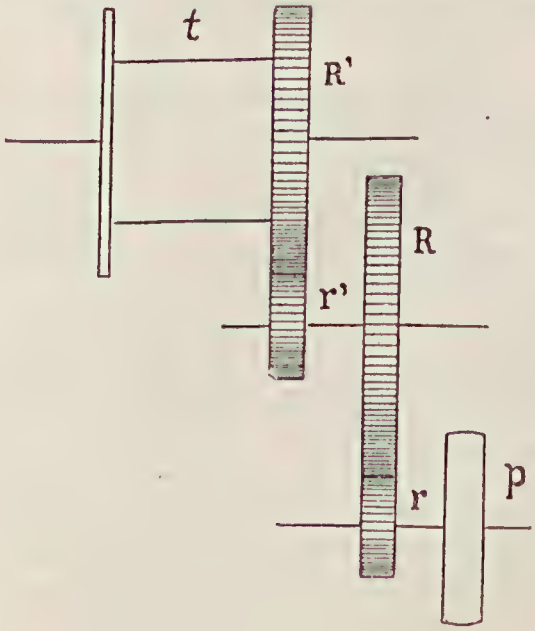

Fig 2.—Toothed-wheel gearing.

which the transmission pulley is fixed, connected by a belt to a horse-gin or portable engine. If an effort P is applied on the pulley p, the pinion r will revolve the wheel R, the pinion r will revolve the wheel R′ and the drum t, and if a rope is coiled on the drum at the extremity of which is a resistance Q, in the form of a load to be hauled, the load will gradually move towards the machine. Disregarding frictional losses and the rigidity of the rope,

l, being the radius of the pulley;
a, the radius of the drum;
R, R′, r, r', the radii of the toothed wheels, or the number of their teeth; we have, theoretically—

$$\frac{P}{Q} = \frac{r\ r'\ a}{R\ R'\ l'} \text{ or } P = Q \times \frac{r\ r'\ a}{R\ R'\ l}$$

As $a\ r'\ r$ are always very small compared to R R′ and l, P is very small compared to Q, we can, with the toothed wheel gearing train, overcome considerable resistances, which, with the simple capstan, would have been impossible. But we must not forget that this gain in power, and consequently diminution of velocity, corresponds to a loss of time so much the greater as the gain in itself is higher.

It is surprising to notice that the wheel-and-axle principle so extensively applied for a long time in other industries, and constructed under so many different forms and dimensions, has been so tardily applied for the draught of agricultural implements.

Deforges, constructing engineer, in an interesting report, after a special competitive show of horse-gins and winding drums held at Narbonne in 1888, relates that before 1815 an old sailor in the Département of the Pyrénées established a capstan at the end of a small field, by means of which he hauled his plough, and consequently cultivated his land. In the same report, Aubert, a land-owner, in the Département of Basses-Alpes, is also mentioned as having used a capstan for hauling his ploughs in 1834. But these isolated trials remained for very many years without creating a movement in favour of these devices.

Nothing less than the destruction of vines by phylloxera and the general necessity of reconstituting the different vineyards was necessary to compel attention to the merits of these machines.

Deep cultivation, such as is now actually done, is almost impracticable with bullock or horse teams, whatever be the number of animals. In the first instance, the farmer must possess enough animals, and only a few can spare fourteen or sixteen draught animals; and what is more, when more than ten or twelve horses work together, their power is very badly utilized, as each animal does not furnish the power it is capable of yielding when alone, and a moment comes when nothing is gained by adding another animal. This loss of power is more noticeable with horses, as they get nervous, and with which it is difficult to obtain regular traction. Finally, in the management of a large team, the starts and turns are extremely difficult. Therefore, the execution of this work has only been possible so far with a steam plant. The Fowler system is the only one that has hitherto been available to viticulturists; however, its use is not without drawbacks. Its high cost and expensive attendance preclude it from the reach of vinegrowers, who, as a rule, only hire it. In this case it is often difficult to get it at the fixed date for a contract time for small surfaces to be ploughed, etc. The travelling on roads or over culverts of these powerful locomotives used for driving heavy ploughs has grave inconveniences. It was, therefore, indispensable to devise a new machine to replace the expensive and cumbersome material used in Fowler's steam ploughing, and place within the reach of all small, medium, and large growers the means for trenching or subsoiling their ground. In 1876 Grué, a vinegrower at Solliès-Pont (Var), first applied the capstan as a mode of traction for trenching or subsoiling ploughs. It is easy to imagine a plough secured at the end of a steel wire cable, winding round the drum of a capstan, and two horses yoked at the extremity of the bars of the capstan, to understand that these animals will put the plough in motion. If the drum has a radius of 19 inches, and if the bars have a length of 16½ feet, the two horses will do the work of a team of twenty applied directly to the plough. But the plough will travel ten times slower. This question of speed and time is, however, generally of secondary consideration, as the capstan allows the grower to plough to depths which he could not reach without using steam, even if he had twenty horses at his disposal, and such a team could not be practically managed.

The purchase of a great number of horses for work of short duration has this double disadvantage, that, firstly, they could not be sold again without a loss ; and, secondly, the inclemency of the weather may interrupt the work, in which case the horses are fed without being utilized. With a horse-gin one may, without increasing the staff and teams, perform better work than would be the result if direct draught were used.

Grué's idea, although so simple and practical, was not immediately adopted by agriculturists, and the gin adapted to the traction of ploughs by horses, or oxen, did not come into general use as rapidly as might have been hoped, considering the requirements of viticulturists. Ten years elapsed before the gin conquered at last, and gained the confidence of all.

In the meantime, Bourguignon, who constructed the first machines for Grué, made a certain number of other gins, particularly the Valessie gin. But it is to Beauquesne, of the Ecole Polytechnique, that the honour is due of having, thanks to a profound conviction and obstinate persistence, forced agriculturists to adopt these machines.

Although the Beauquesne gin is an enormous advance on the machines constructed previously, it is not without several defects. The ingenuity of constructors was awakened by the success of these machines, and did not take long in triumphing over the difficulties which their application presented in practice, and the last show of gins, which was held in the spring of 1890, proved that the gin had at last become an implement of great perfection.

While this transformation was taking place, Grué on one side, Beauquesne on the other, were trying to apply the capstan system to the utilization of portable engines for the draught or traction of ploughs. As the horse-gin allows viticulturists to do with two horses cultivation which would require twenty in the ordinary manner, the steam winding drum gives, in the same way, the means to do with a small portable 6 H.P. engine, work which formerly required powerful winding drums of the Fowler system. The steam winding drum is nothing less than a toothed wheel gearing train, the pulley of which is connected with the belt of the engine. Although the principle of this machine seems very simple, it had to be devised so as to render the winding drum

practical. The Perpignan show enabled us to appreciate the progress accomplished in this direction; and, even if some modifications of detail yet remain to be made, viticulturists have already at their disposal new machines of great power and of incontrovertible utility.

There are two classes of trenching or subsoiling capstans:—1st, the horse-gin, for use by the medium grower; 2nd, the steam-winding drum, for properties possessing a portable engine. The machines of the latter class may be used for small properties, through contractors undertaking the work. The trenching or subsoiling per acre with this contrivance is generally less expensive than with Fowler's machines, on account of the considerable difference in the prices of the plants.

Horse-gins or Whims.

Horse-gins are divided into:—1st, fixed gins; 2nd, movable gins. While the former are established in a fixed position of the field to be trenched or subsoiled, and are fixed during the whole time of the duration of the work, the latter are arranged on one side of the plot to be ploughed, and are displaced in front of every furrow, travelling from one extremity of the field to the other. In the first class may be grouped the Beauquesne and Musquère systems; in the second, all other systems.

Beauquesne's Horse-gin.

Although the Beauquesne machine is not the first that was used for deep cultivation, it is certainly the best known. It was first used in 1887. Since that date it has been improved in details, but as a whole has remained as it was when first brought out, remarkable for its great simplicity and rusticity.

Description.—The complete machine is composed of three essential parts—A *capstan*, *cable*, and *fixed pulley*.

The capstan consists (Fig. 3) of a drum C, the diameter of which may vary between 27½ inches and 4ft. 3in., around which the cable is wound. This drum runs loose on the vertical shaft, which is strongly fixed to a cast-iron cross bolted on a wooden base frame, formed of two beams 9ft. 9in. in length. A coupling clutch P, running loose on the same shaft carries the pole B. The throwing-into-gear lever L, allows the raising or lowering of the clutch P. When raised it is independent of the drum C. When

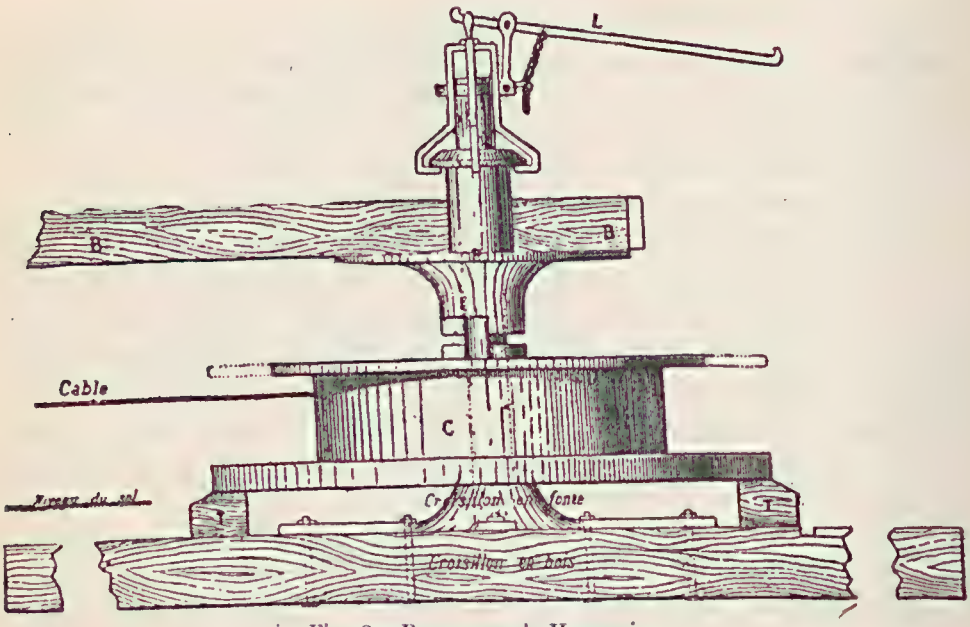

Fig. 3.—Beauquesne's Horse-gin.

lowered, on the contrary, it throws the drum into gear, and the horses yoked to the pole B, in their circular motion wind the cable on the drum. The machine increases the draught ten times.

The cable is made of steel wire. It is about 274 yards long, and generally 0·51 to 0·55 inch in diameter.

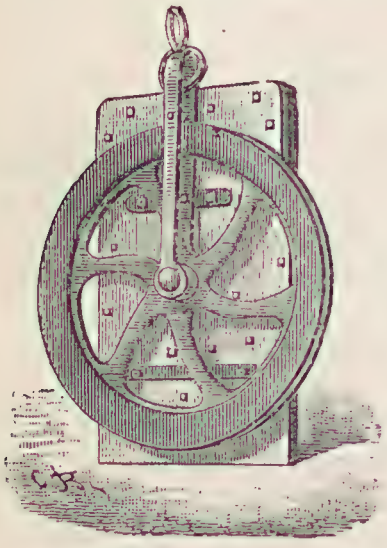

Fig. 4.—Fixed Pulley.

The fixed pulley is a shive supported by a wooden framework, through which passes the axle (Fig. 4). A length of chain, ended by a large link, allows the frame to be fixed to another chain, the extremities of which are secured to two anchors deeply buried in the ground. By this process the pulley may easily be displaced on the ground, by allowing the terminal link of the small chain to slide along the large one without removing the anchors.

Working.—Under one of the beams of the frame of the capstan, an axle is attached by which the machine is fixed on wheels, to facilitate travelling it from one place to another. Two excavations are made in the ground for the

wooden beams, the wheels are removed, the capstan placed in position in the excavation, and fixed by a few iron or wooden pegs. The gin is generally placed at one angle of the field to be ploughed (Fig. 5). After lifting the coupling clutch the cable is unwound and passed over the fixed pulley,

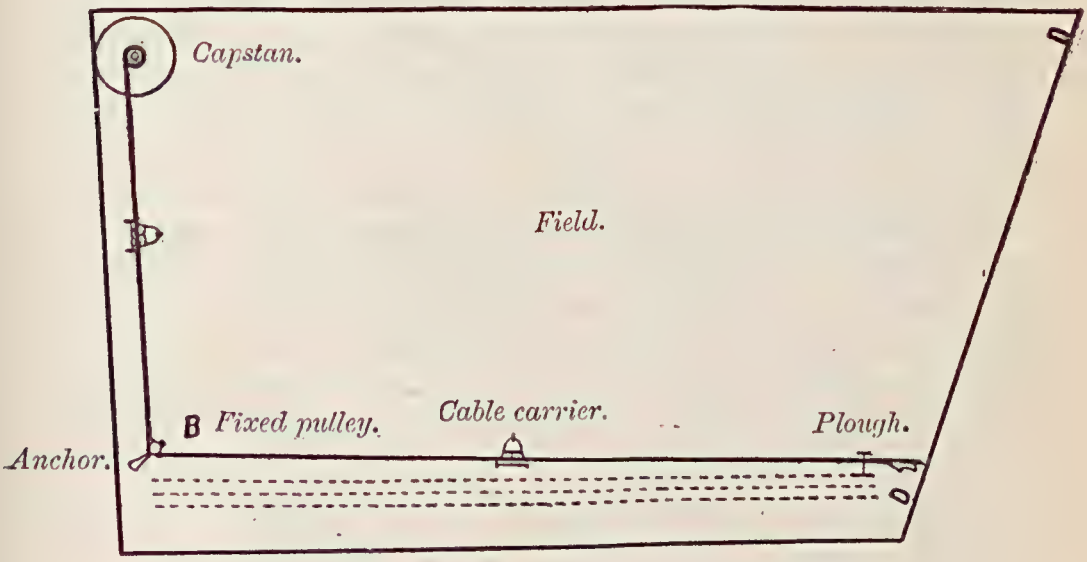

Fig. 5.—Arrangement of Capstan in the Field

which is anchored at the extremity of the first furrow to be turned by the plough, to which the free extremity of the cable is fixed. When the distance is considerable the cable is supported by cable carriers (a kind of small carriage provided with a ground pulley) to diminish the wear and tear (Fig. 6). At a distance of about 19 feet from the capstan a small device is placed for facilitating and regulating the winding of the cable on the drum. The horses are then harnessed to the pole, the machine thrown into gear, and all is ready for a start.

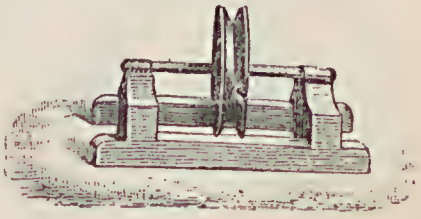

Fig. 6.—Cable carrier.

The installation is simple, and does not require much skill; the fixation of the anchors which hold the fixed pulley, alone presents some difficulty. It is necessary to prevent the enormous traction exerted on them from pulling them out of the ground. When the soil is naturally compact and resistant this need not be feared, but in swampy or light gravelly soils it is difficult to keep the anchors in

position. This accident is so frequent with the anchors that Beauquesne was forced to discard them and substitute anchoring plates, the resistance of which is much greater. These plates, formed of strong girders, lodged in trenches in the ground, and resting on an extended surface, support very considerable efforts without yielding. It is not rare, however, to see them pulled out of the ground in certain soils. It is preferable, when circumstances allow it, to anchor the pulley to a wall or trees ; even these are sometimes pulled out.

It should be noticed that the two anchoring points of the chain holding the pulley have to sustain unequal tractions, and that the pulling out of one end is more to be feared than the other. This is shown in Fig. 7 ; the traction T of the capstan and the resistance T′ of the plough give a resultant F applied to the point *d*. This resultant is equilibrated by the resistance R of the anchoring chain. If this

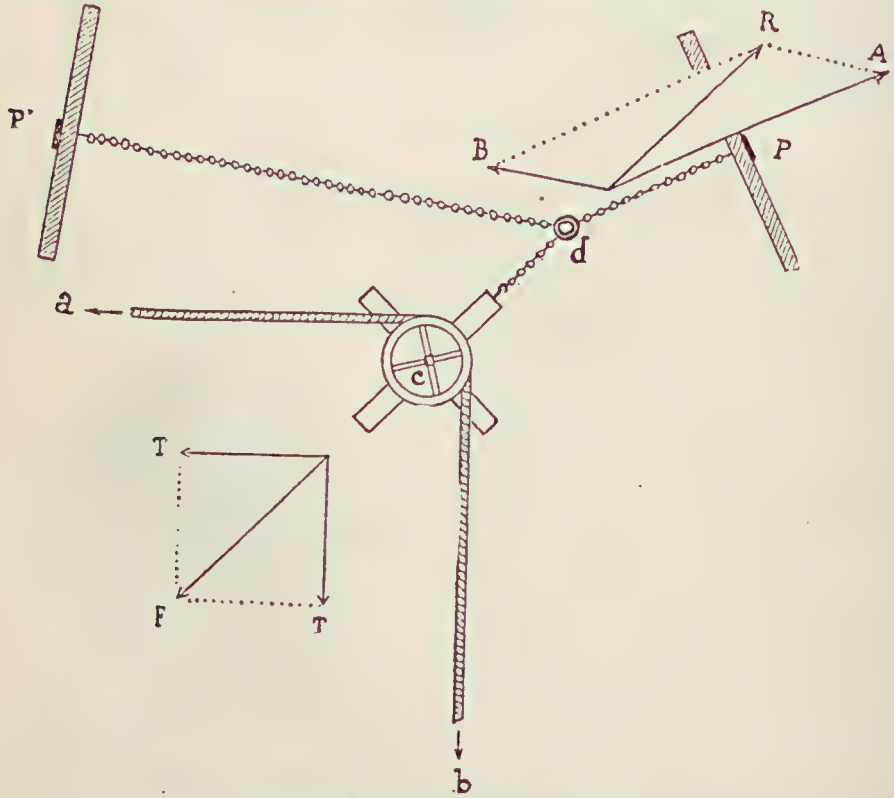

Fig. 7.—Anchoring of the Fixed Pulley.

resistance is resolved into its two components, A directed towards the anchor P, the other B directed toward the anchor P′, we see that the effort applied to the first anchor is greater

than that applied to the second, and greater than the traction of the capstan or the cable. In practice the anchor plate P gives way before P′, therefore the anchor plate P requires to be fixed more carefully. This is the greatest defect of the system.

The plough made on the Brabant system is of great power, all the parts being strengthened and strongly braced together. When the plough hauled by the cable reaches the fixed pulley, the plough is thrown out of gear, leans on the mould-board, and comes out of the furrow. The coupling clutch is thrown out of gear, the capstan stops revolving, and the plough is lifted up, placed on a small two-wheeled truck, and hauled by a horse to the starting point of the new furrow (Fig. 8). To regulate the unwinding of the cable, the driver acts on the

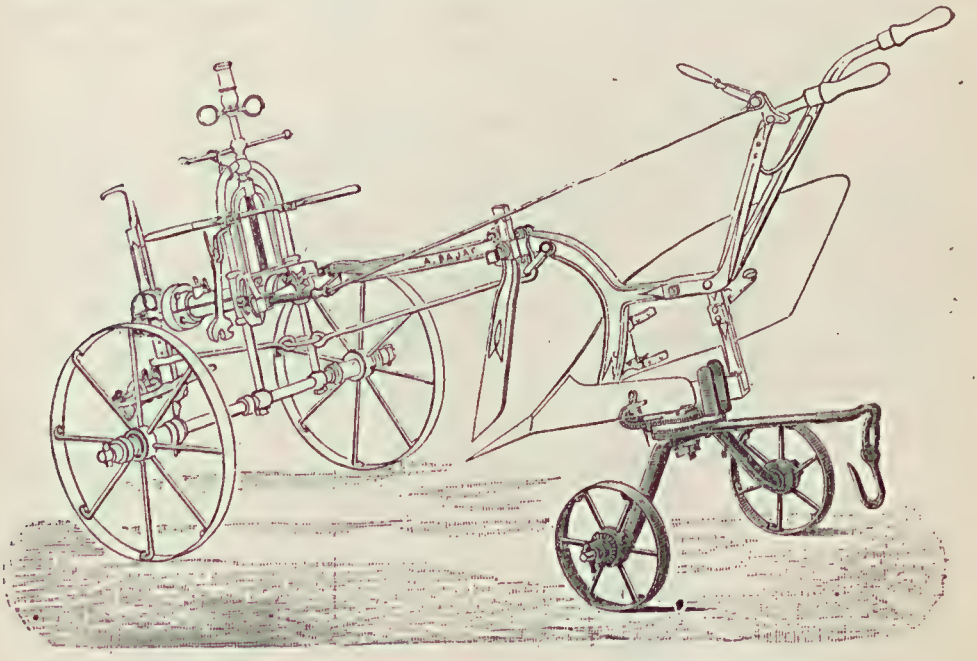

Fig. 8.—Plough ready to be hauled back.

drum with a wooden lever as a brake. While this is done the chain of the fixed pulley is shifted along the anchoring chain to a distance equalling the width of the furrow, so as to have the chain opposite the furrow to be opened, and the operation is again repeated.

If the field to be ploughed is too large to allow the work being done from one position of the capstan, without detrimentally increasing the length of the cable, it is partitioned in a series of rectangular blocks, the position of the capstan being changed as many times as there are rectangles. We

may reduce the number of shiftings by placing the capstan in the middle of the plot, instead of a corner. In this case, with a cable 274 yards long, one may, without shifting the capstan, plough about 15 acres. At the end of the work non-ploughed headlands are left. On the side where the capstan and pulley are fixed the headland is 23 to 26 feet in width ; on the other side, about the length of a horse. The headlands are ploughed in the same way as above described, leaving only four small squares unploughed at each corner of the field.

The traction cable is not buried, and passes across the circular track made by the horses. They have to walk over it. They very quickly become accustomed to this, and the slow rate of the cable renders it very easy, the drum being level with the ground the height of the cable does not exceed 9 inches from the surface. This arrangement has been proved to be the most practicable and simple, and without danger to the horses.

Two objections may be raised against the Beauquesne system. The first is relative to the difficulty of anchoring the fixed pulley, the second relates to the shifting of the capstan from one place to another. Notwithstanding these objections, this horse-gin remains the most practical, and on account of its simplicity and strength it has and will still render great services to viticulturists. Its price is £48, including 220 yards of cable, plough excluded.

The plough used by Beauquesne is that made by Pol Fondeur, at Viry (Aisne) specially strengthened to resist the enormous effort it has to support (Fig. 9). It is a good

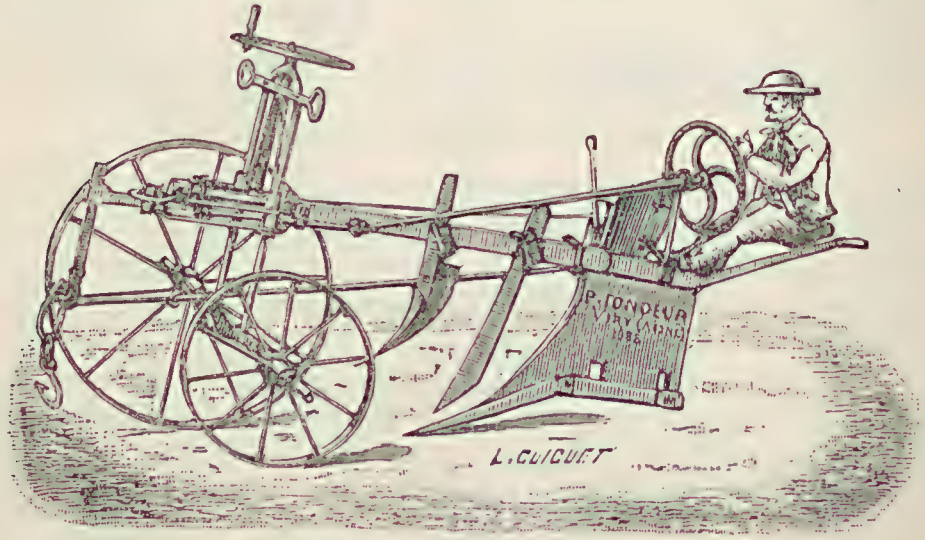

Fig. 9.—Pol Fondeur's Trenching Plough

implement. Only the fixing on the truck to bring it back to the beginning of the furrow is a rather troublesome and tedious operation. It is done as follows :—The beam of the plough carries a vertical shaft with a toothed rack, gearing with a pinion. Directly the plough has come out of the furrow leaning on the mould-board, or breast, it is lifted upright, a plank is placed under the vertical shaft, and, by means of a handle working the pinion the shaft is lowered. It rests on the plank lifting the body of the plough. The truck is slided under the frame and keyed on to it. The shaft is then raised and the plough resting on the truck is ready to be drawn back. This device is shown in Fig. 8.

Musquère's Horse-gin.

The horse-gin of Musquère, of Salses (Pyrénées-Orientales) presents some analogy to that of Beauquesne.

Description.—The frame of the capstan is made of rolled joist girders, braced with angle iron.

The winding drum is 3ft. 3in. in diameter, the pole 11 ft. in length. The ratio of the speeds $\frac{1}{63}$. Two poles may be fixed on the socket head. The device for throwing into gear resembles that of Beauquesne.

Working.—To instal the capstan a deep trench is dug to receive the wheels and frame. The machine is buried to the level of the bottom flange of the drum. The stability is great, but the fixing tedious. The cable passes over a fixed pulley made fast to a chain, the two extremities of which are anchored to a series of iron pegs arranged like a claw. The sliding of the pulley on the anchoring chain is done in the same way as with the Beauquesne plant.

The plough used is a Vernette trenching plough. To carry the plough back to the beginning of the new furrow, it is tilted over on two wheels.

This gin with 274 yards of cable costs £64.

Grué's Horse-gin.

Léonce Grué first attempted in 1876, on his farm at Beaulieu, Solliès-Pont (Var), to haul heavy trenching ploughs by means of a winding drum. The first machine was very imperfect, but the principle was good, and Grué had only to make a few modifications to create the horse-gin which now bears his name, and which is sometimes known under the name of Beaulieu gin.

Description.—It consists essentially of a horizontal winding drum (Fig. 10), made of sheet steel and angle iron.

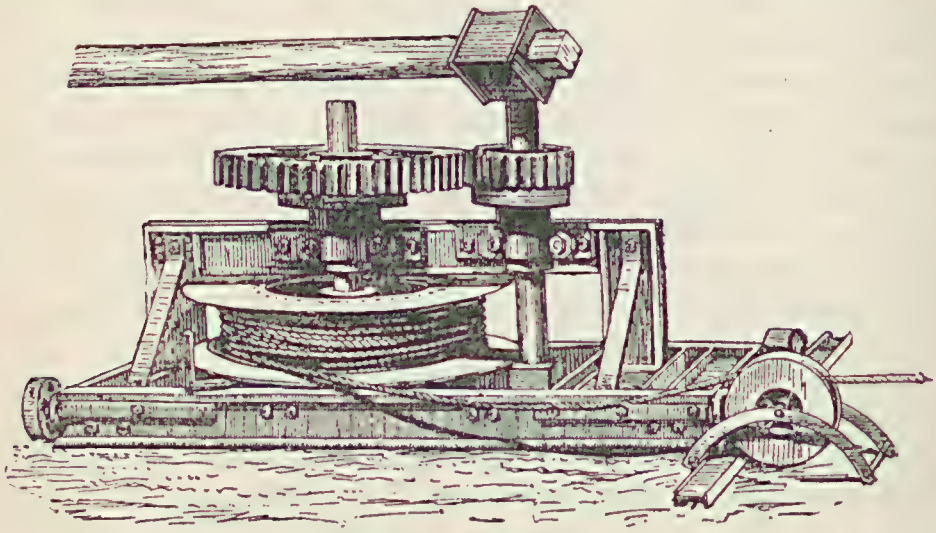

Fig. 10.—Gruć's Horse-gin.

It is very strong, and is set in a frame made of iron rolled joist girders and T iron, easily dismounted by means of bolts. Above the frame a pair of cog-wheels are interposed between the pole axis and the drum axis, which according to their position, allow different rates of winding to be obtained, and consequently different powers of traction. A pole-socket fixed on one of the vertical shafts carries the pole, the frame rests on four rollers, rolling on two rolled joist girders, placed flat on the ground, and serving as rails.

This gin has three speeds. For very deep cultivation, requiring great traction, the large cog-wheel is keyed on the drum shaft, and the pole-socket keyed on the shaft of the small pinion. In this case the traction on the cable is to the power of the animals as 20 is to 1. For ploughing at a medium depth, the pole-socket is keyed directly on the drum shaft, working independently of the cog-wheels. In this case the effort is increased ten times, as in the Beauquesne machine. If the working of the land does not require so much power, one may work quicker by fixing the small pinion on the drum shaft, and the large cog-wheel on the shaft carrying the pole. The effort in this case is increased five times. The shifting of the cog-wheels is done very easily. They run loose on the shafts, and are engaged by means of a cotter fixing them to circular plates, placed underneath and keyed on the shaft.

Working.—The gin is installed on the shortest side of the block, and opposite the first furrow to be opened. It is carried by two rails fixed in the ground by means of pegs. The weight of the machine is sufficient to keep it in place. The cable is made fast to the plough, and acts directly without passing over a fixed pulley. This pulley would only be necessary in the case of a block of irregular shape, where the gin could not be easily brought opposite the furrows. The horses in their circular track haul the plough, which, when it reaches the machine, is tilted on its side, placed on a small truck, and carried back by a horse to begin another furrow. While the plough is being taken back the gin is moved forward a distance equal to the width of a furrow. When the machine reaches the end of the rails, a second pair of rails is placed in line ; when the machine is on these, the first pair is taken up and placed in line in their turn. Four rolled joist girders are therefore sufficient for travelling the gin along the headland. The machine travels by degrees from one end of the block to the other, leaving only two headlands unploughed. The headland on the gin side is about 40 feet wide, on the opposite side 11 feet.

The dispensing with the fixed pulley, and displacement of the gin on rails, are the characteristic and principal advantages of Grué's gin. This advantage is considerable, as the installation of the machine is much simplified ; for the doing away with the pulley avoids the difficulty of anchoring, which is an almost insurmountable difficulty in certain soils. Grué's machine for these reasons has had many imitators, and movable gins are nowadays mostly used. The contrivance allowing three different speeds to be obtained is not very useful. Increasing the motive power by ten is quite sufficient, as in this case two horses exert an effort equal to twenty yoked directly to the plough. By increasing this power at the expense of the speed the latter is too much reduced, and the daily work done by the plough becomes insignificant ; by diminishing it on the contrary the use of a winding drum is not justified, for its aim is simply to allow deep ploughing, impossible to be performed with ordinary teams. The cog-wheels of the Beaulieu gin could therefore be dispensed with, the socket head keyed directly on the shaft of the drum would greatly simplify the machine.

Its price without cable or plough is £64 ; without the cog-wheels it only costs £40.

The gin hauls a trenching plough, built specially for it by Durand, of Montereau (Seine-et-Marne). This implement (Fig. 11) is of very great power, and allows land to be ploughed easily to a depth of 2 feet. It has three coulters with a steel share, made in such a way as to keep the plough well into the ground. All the regulating may be done during work without stopping, by means of a hand-wheel acting on screws; a small wheel is fixed at the rear of the plough to take it back to new ground. This wheel revolves on a lever, at the extremity of which is a hook. During the ploughing the small wheel lifts automatically and revolves on the bottom of the furrow opened by the plough. To carry the plough, the swingle bar is secured to the hook of the lever; the traction of the horse lowers it, and at the same time forces the small wheel to rest on the ground, lifting the frame and allowing the plough to run on three wheels. This small wheel is articulated so as to form a fore-carriage replacing the truck. The plough weighs 13 cwt. 3 qr., and costs £38.

Grué's Double Winding-drum Gin.

Grué also makes a double winding-drum gin, allowing the plough to be worked both ways and avoiding the time lost in pulling the plough back to new ground.

Description.—This gin is composed of two drums, each winding a cable. One of these is fastened directly on the plough, the other one, which is longer, passes over a fixed pulley anchored on the opposite headland, and is then made fast to the plough; these two drums may at will run loose on their shafts or be keyed on to them. It is easy to understand that these two drums will alternately wind and unwind the cable, drawing the plough backwards and forwards, therefore the ploughing will take place both ways without loss of time. The plough in this case must evidently be either a turn-wrest plough or a balance plough, turning the sod on the same side during its passage both ways. (See Figs. 12 and 27.)

In this case the difficulties again reside in anchoring the pulley. Grué solved the difficulty in the following way:—Three iron beams, 10 feet in length, are placed one above the other with a space of 4 inches between each. Corresponding holes are punched out of each beam, and a spindle serving as axle to the pulley passed through

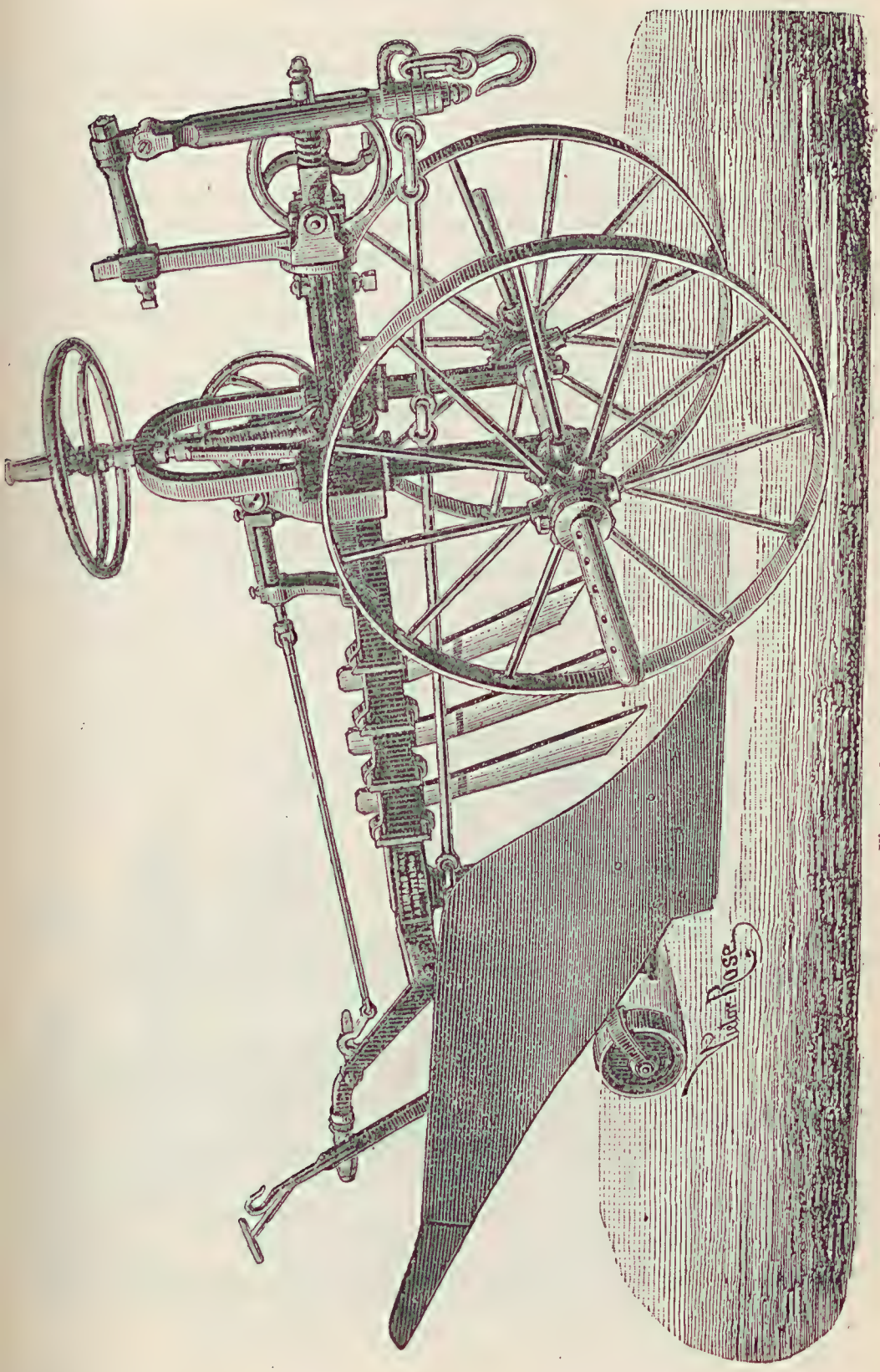

Fig. 11.—Durand's Trenching Plough.

them. To shift or displace the pulley at each furrow, the spindle is taken out and put in the next hole, and so on. The beams are kept in the ground by means of strong iron posts, and the device has only to be moved every 10 feet.

This method of fixing the pulley is not without drawbacks, and in pebbly, light, or boggy ground, the pulley rapidly drags the beams out. It has, as a matter of fact, to resist a traction double that resisted by the gin, as the two parts of the cable passing over the pulley are parallel, and the stress on each part is equal to the effort of traction exerted tangentially to the circumference of the drum. Notwithstanding Beauquesne's anchoring plates, the fixed pulley of his machine (the resistance of which does not require to be double that of the effort of the capstan) is often dislodged. We cannot, therefore, expect greater stability on the part of the fixed pulley of Gruè's system. This compound machine, the main advantage of which seems to be the rapidity of execution of work, cannot in reality attain much greater rapidity, as the displacement of the pulley,

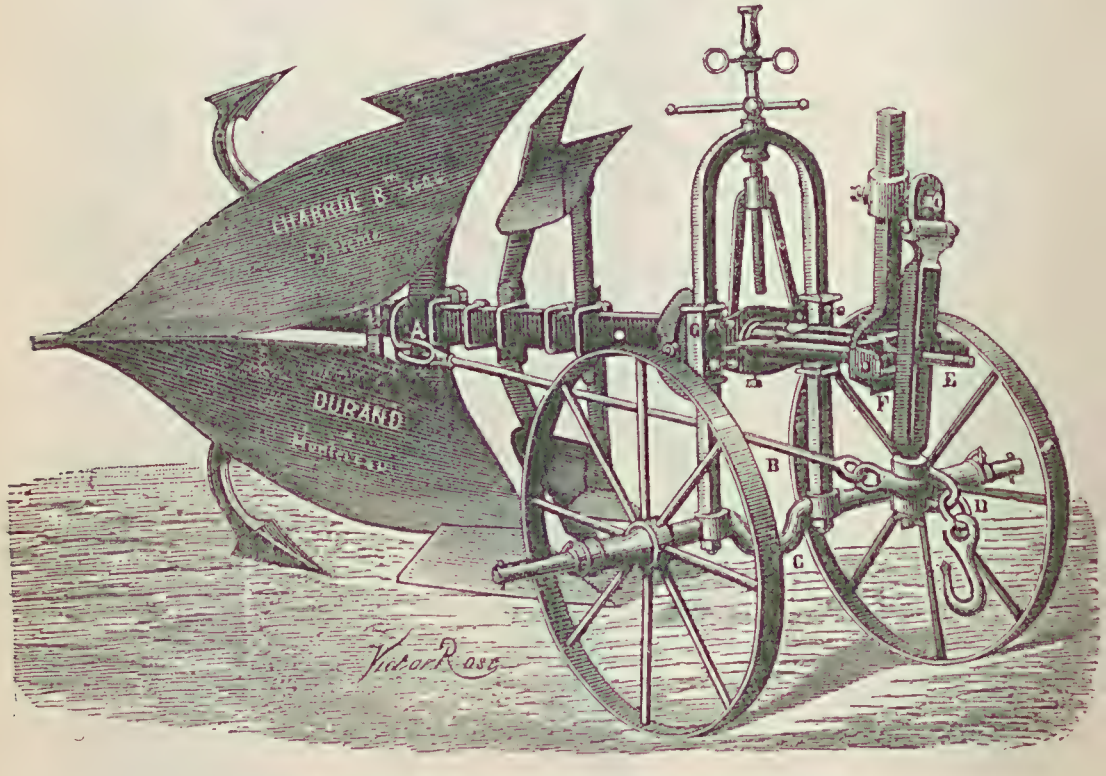

Fig. 12.—Durand's Turn-wrest Plough, with Subsoiling Tines.

the anchoring, the possible dislodgment, are so many drawbacks to the regular working. Its high price, £100, is, on the other hand, an obstacle to its use by small and medium growers. The turn-wrest plough, with a subsoiling tine (shown in Fig. 12), may be used with this capstan. In soils of medium stiffness, the trenching part of the plough works at a depth of 16 inches, the subsoiling share working 6 to 8 inches deeper, making the total depth of work 22 to 24 inches.

Durand's plough costs from £20 to £30.

Bourguignon's Horse-Gin.

Auguste Bourguignon, who first constructed the Grué gin, has, since 1887, built the Valessie gin.

Description.—This gin is composed of a cast-iron bed-plate, the dimensions of which have been calculated so as to enable it to be carried on an ordinary dray. This bed-plate rests on two long axles (Fig. 13) each bearing two rollers, rolling on angle irons bolted on wooden beams. On this bed-plate a frame-work or *bridge* is bolted, inside which the drum is placed, keyed on a vertical shaft, revolving on a bronze cup socket in the centre of the bed-plate, and through a collar in the upper part of the bridge. On the top of the shaft a circular plate is keyed, perforated with six holes at

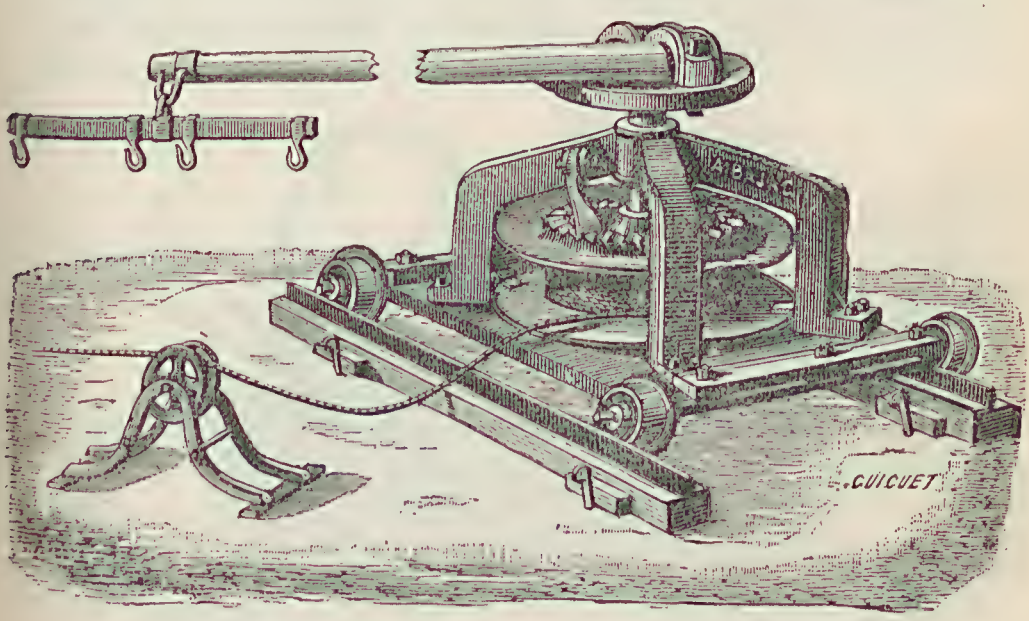

Fig. 13.—Bourguignon's Horse-gin.

the periphery, above it the pole socket-head runs loose on the shaft, but may be clamped to the plate by a jumping cotter. A pawl prevents the drum unwinding in the case of the horses backing. It also prevents accidents which might arise from a swingle-bar or pole breaking during the work. If such a breakage occurred, the strain on the cable would cause the drum to revolve backwards, carrying in its rotation the pole, which might injure animals, driver, or onlookers if too close.

The jerky, clicking noise produced by the falling of the pawl on the ratchet-wheel arouses the attention of the driver, renders the supervision easier, and breaks the monotony of the work. The radius of the drum is 12 inches, and reaches 16 inches when the cable is wound up. The pole is $16\frac{1}{2}$ feet in length ; the moving power is, therefore, multiplied by 12·5. The speed of the plough may be increased a little, and the power diminished, by inserting wooden sectors between the flanges of the drum, which increases its diameter. The same result may be obtained by yoking the animals nearer the axis of rotation, that is to say, by diminishing the length of the pole, which is easily done by hooking the swingle-bar to hooks fixed on the pole for this purpose.

The animals, two or four in number, are yoked to one or two poles, as the case may be.

The cable is not fixed directly on the plough ; it is fixed on a cable-carrier, which is secured to the plough by chains. This cable-carrier, which is the characteristic of this system, consists of an axle and two large cast-iron wheels (Fig. 14).

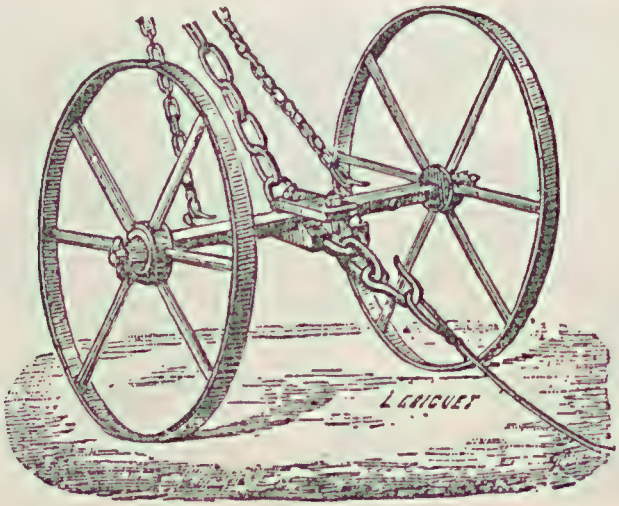

Fig. 14.—Cable-carrier used with Bourguignon's Gin.

It is provided with a hook, to hook on the end of the cable, and is connected to the plough by three chains, the two lateral serving to fix it askew to the direction of the plough.

The advantages of this device are as follows :—1st., it allows a very straight furrow to be turned, even if the cable pulls sideways, and therefore to only displace the gin every five or six furrows. The ploughman has only to work the side chains in the necessary manner, which is done without loss of time ; 2nd, it prevents the plough from coming out of the ground, on account of the height of the point of traction. In fact, in most systems of gins it is necessary to alter the rear of the frame to keep the plough in position. This is usually done through the weight of the ploughman sitting on a seat fixed at the rear between the stilts.

The plough used by Bourguignon is the simple Brabant, specially constructed by Bajac for ploughing to a depth of $19\frac{1}{2}$ to 24 inches, and provided with the following contrivance for carrying it back after each furrow has been ploughed :—The rear of the frame is traversed by an iron rod, threaded at one end, the other end carrying a small wheel ; a handle nut allows the rod to be raised or lowered. When lowered the wheel rests on the ground, the body of the plough being lifted, and, resting on the small wheel and the wheels of the forecarriage, is easily transported. The height of the small wheel can be regulated, so that, when working, the plough rests on it ; a rolling friction being substituted for the sliding friction of the frame. The Bajac plough is shown in Fig. 15, without the lifting device.

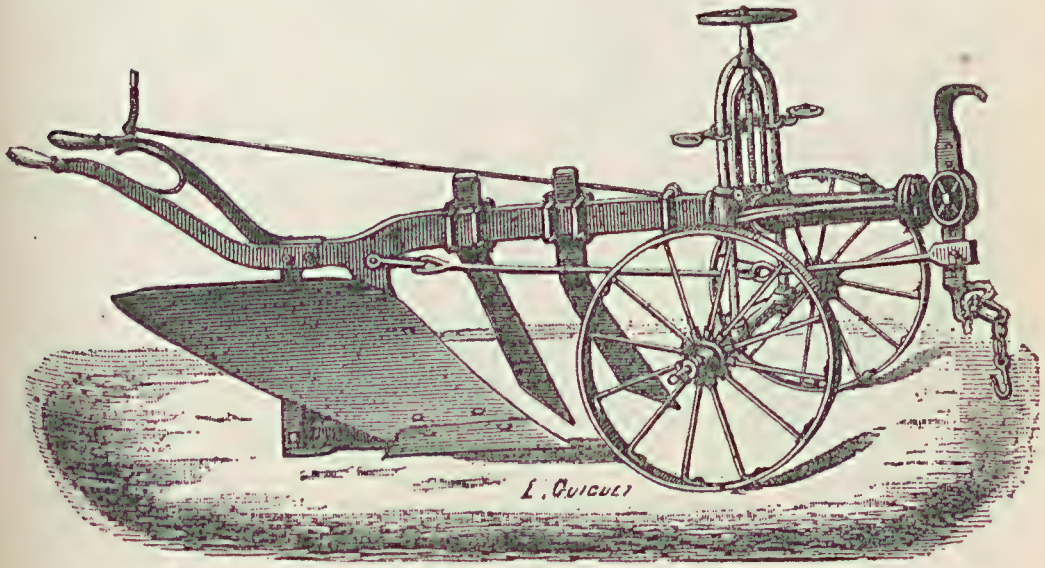

Fig. 15. Bajac's Trenching Plough.

Working.—This gin works like that of Grué. Installed on one side of the block, it pulls the plough from the opposite side. The rails on which it travels are kept in place by a few pegs. The non-ploughed headlands have the same dimensions as in the previous case.

Guyot's Horse-gin.

Guyot, implement maker at La Redorte (Aude), has devised a gin of great simplicity, which is easily worked. It obtained at the special show at Perpignan, in 1890, the first prize and a gold medal. It is a travelling gin, without either roller or rails.

Description.—It consists (Fig 16) of a large cast-iron bed-plate, provided with an axle to enable it to be shifted about ; during work the bed-plate rests on the ground. On the centre of the plate a vertical shaft revolves, kept in position at the top by a curb bolted on the plate. On this shaft the winding drum is keyed, which is 19½ inches in diameter, and on the top of the shaft two poles are fixed 11ft. 10in. in length. The ratio of the speeds are $\frac{1}{12}$, for, when the cable is wound, the average diameter becomes 2 feet.

The gin, resting on the ground, is fastened by means of an iron bar to a chain anchored at each end. To displace the gin at each furrow the iron bar is simply slided along the chain, the traction on the cable then suffices to bring the gin opposite the furrow to be opened. The mode of displacement of this gin is identical to that of the fixed pulley of the Beauquesne system ; but, whereas the pulley drags out the anchors easily, on account of the large traction exerted on one of them (Fig. 7), the Guyot gin is easily kept in place, for the traction is exactly divided on both anchors, the iron bar being always placed in the prolongation of the bisectrix of the angle formed by the two parts of the anchoring chain.

The plough is made by Guyot. It is a simple Brabant, composed of a very strong beam, strengthened by a rolled joist girder, to which the different parts are fixed (Fig. 17).

The depth of ploughing is regulated by means of a screw placed at the rear of the beam. The width and the direction of the furrow are regulated by the position of the

cable hook, by means of a pair of pinions and a hand-wheel. The ploughman can, during work, adjust the regulator rapidly and easily.

The device for carrying the plough back to the starting point is ingenious. A small wheel, carried by a block and spindle, is, during the work, hooked between the handles. When the plough is out of the ground the spindle is inserted in a hole pierced sideways in the framework. By tilting the plough it is forced to rest on that wheel, the implement then running easily on the three wheels.

Working.—Guyot's gin is managed in the same way as the Beauquesne fixed pulley. The two anchors are fixed on one side of the block, the gin secured to the anchoring chain opposite the first furrow to be opened. As the work progresses the bar of the capstan is slided along the anchoring chain. The management of the plough is the same as in any other system. To facilitate the sliding of the gin-bar along the anchoring chain, this bar is tied to the gin by a small piece of chain winding round a small capstan. By acting on the latter, the gin is brought closer to the chain; the loosened bar is then easily shifted. During the carrying of the plough to the starting point a small brake is used to regulate the unwinding.

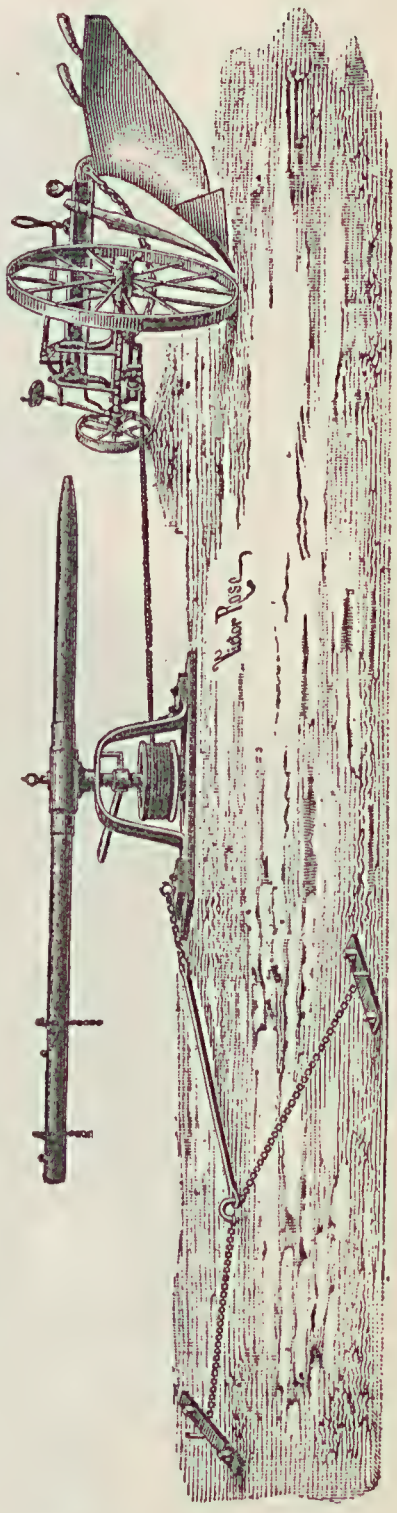

Fig. 16.—Guyot's Horse-gin.

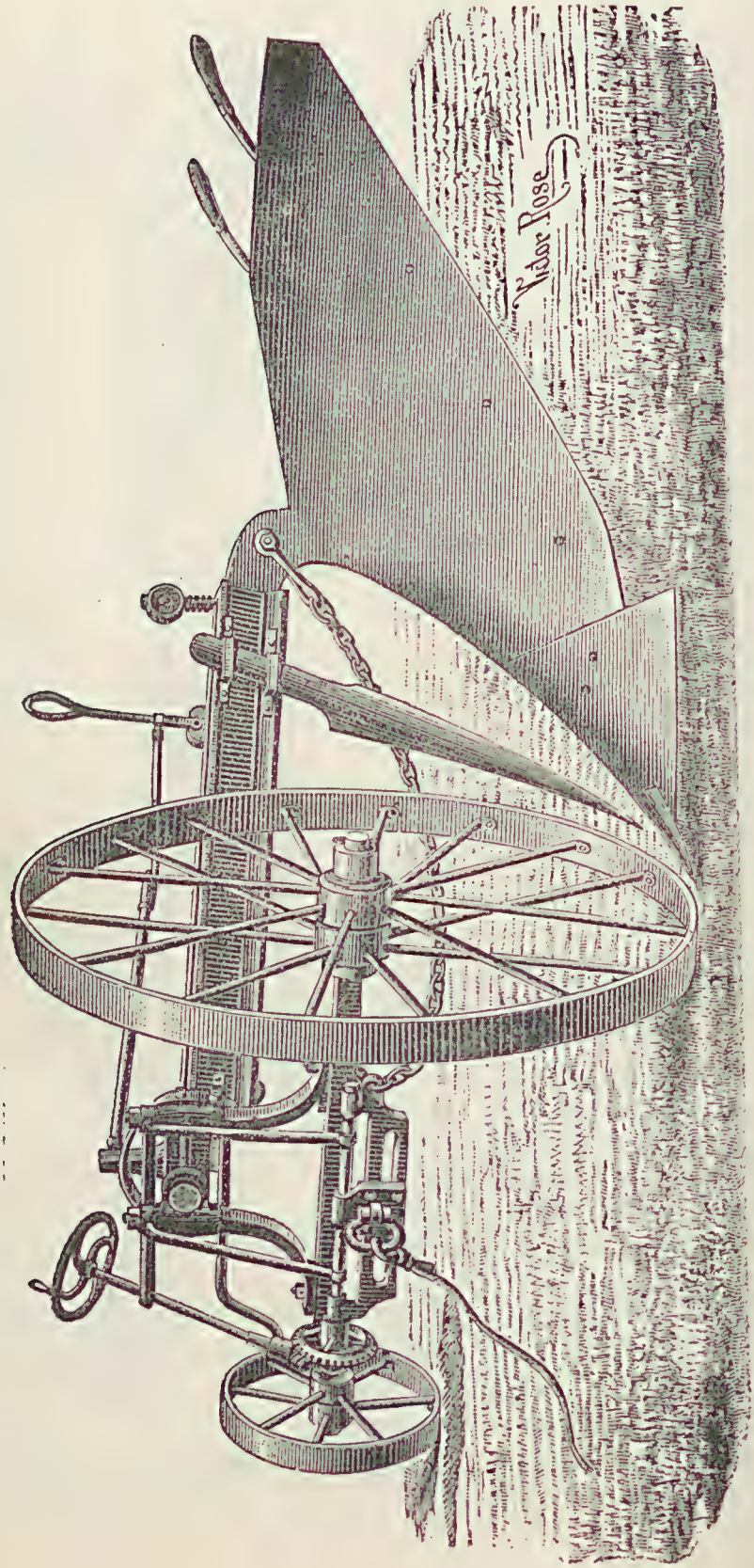

Fig 17.—Guyot's Trenching Plough.

The Guyot gin is one of the simplest and most practical; its cost is only £34, the carrying wheels cost £4, the plough £28, the cable, of 274 yards, £10.

Vernette's Horse-gin.

The gin designed and made by Etienne Vernette, of Beziers, is worked like those of Grué or Bourguignon, by displacement on rails along the headland.

Description.—It is composed of a winding drum 23½ inches in diameter (Fig. 18). This drum revolves round a strong

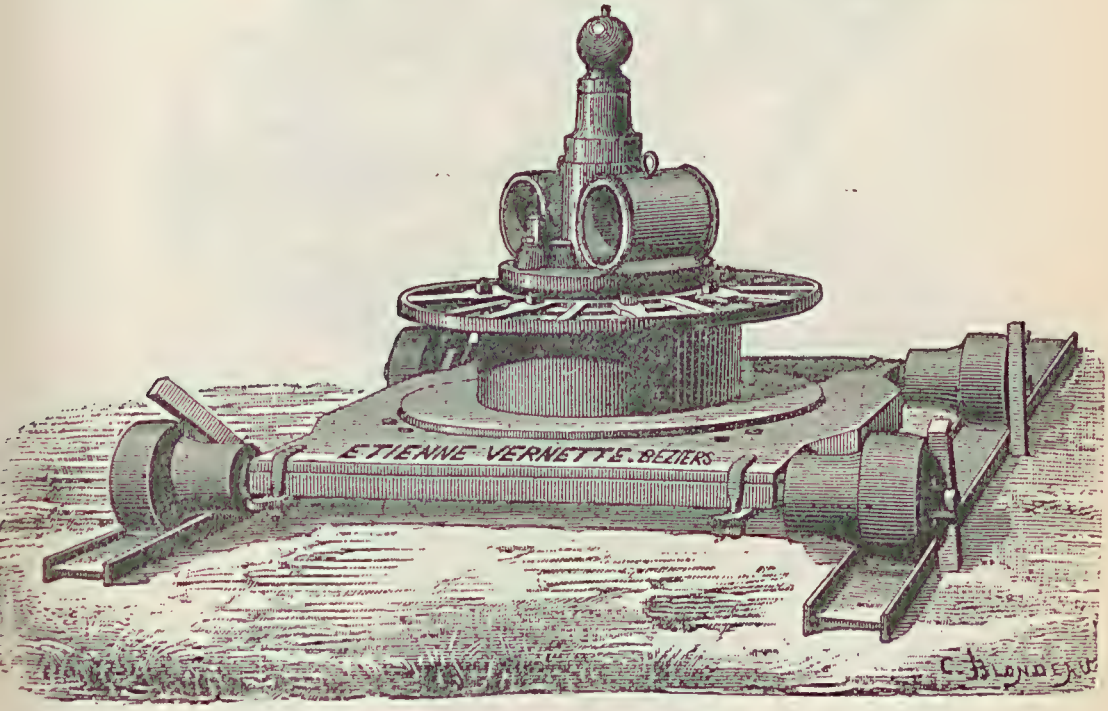

Fig. 18.—Vernette's Horse-gin.

steel shaft keyed on a cast-iron cross, bolted under a cast-iron bed-plate. There is no framework, therefore the cable can take any direction. The bottom flange of the drum is countersunk in the bed-plate, which prevents the cable, when winding up, from being caught under the drum. The whole machine is carried by four massive rollers. The socket-head for the two poles runs loose on the same shaft as the drum; the drum and the socket-head are clamped together by means of two cotters. When the cotters are in place, the animals wind up the drum in their circular motion; when taken out, the drum is disconnected, and the weight of the socket acts as a brake during the unwinding.

If the roads are in good order the animals may be yoked directly on the gin, which travels on the rollers; if not, it may be carried on a dray, or on a truck made specially for

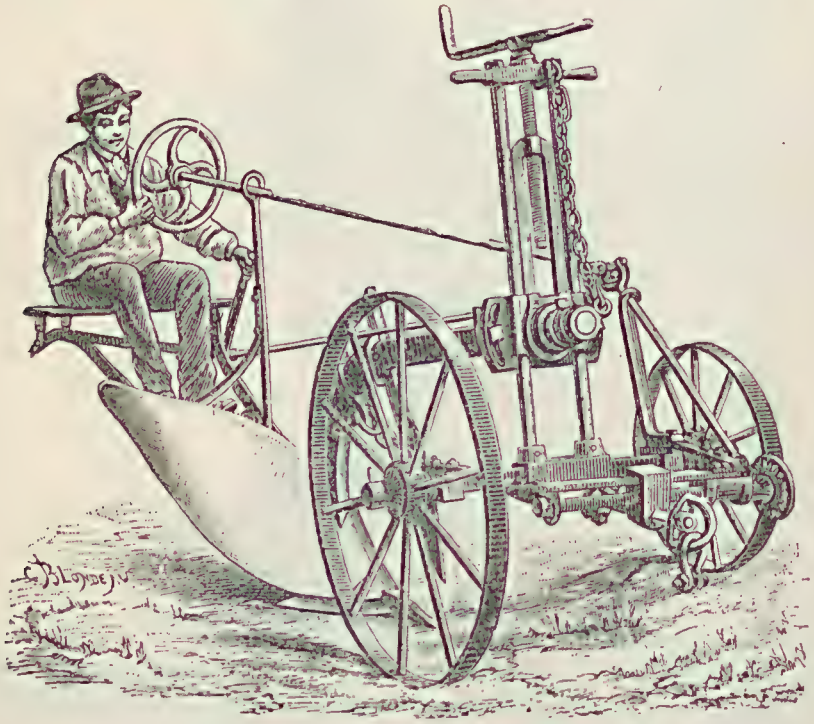

Fig. 19.—Vernette's Trenching Plough.

the purpose. During work the machine is displaced on a pair of rails made of rolled joist girders. Pegs prevent any displacement in the direction of the cable.

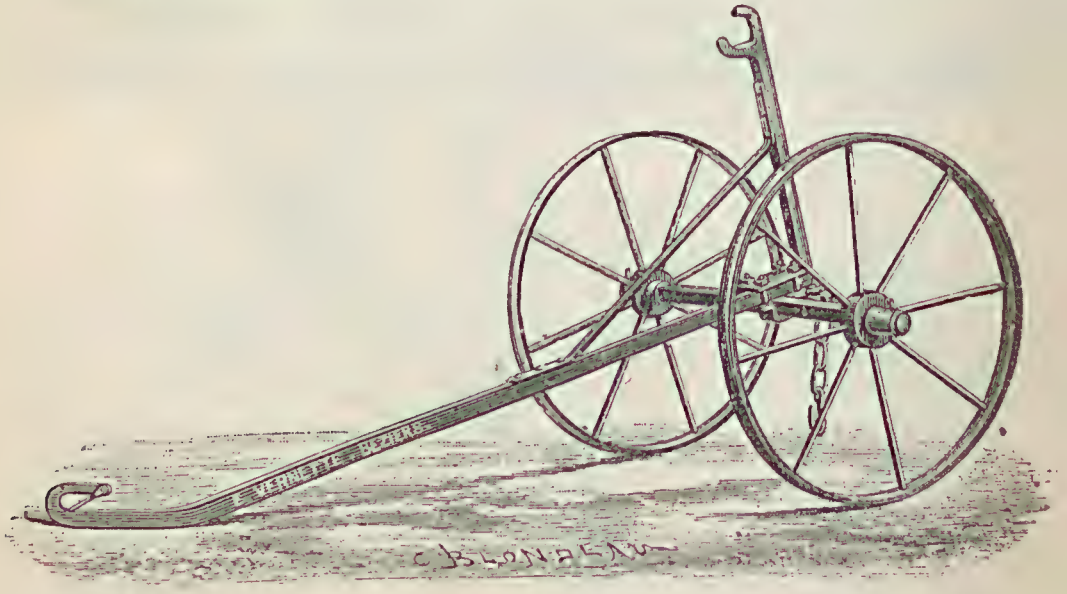

Fig. 20.—Patent Automatic Carrier for Vernette's Plough.

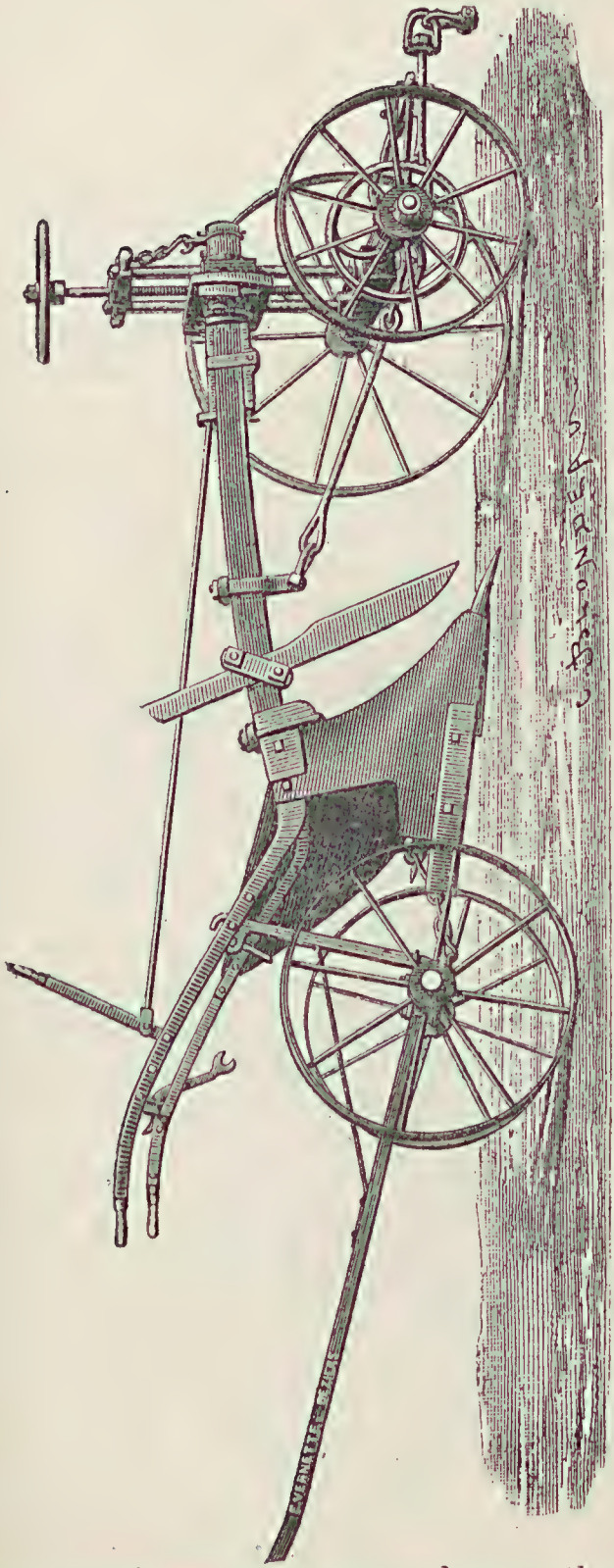

Fig. 21. Plough placed on the Automatic Carrier.

Working. — It works like any other movable gin. It is strongly built, well studied in details, and only costs £34. It is one of the most practical machines offered to viticulturists. It generally hauls a plough specially made for it by the same firm (Fig. 19). It is a simple Brabant, provided with a seat for the ploughman, who can easily regulate and direct the plough by means of a lever placed in front of him. The depth of ploughing is adjusted by a screw on the forecarriage, the width by the lateral displacement of the wheels. A special truck (Fig. 20) is easily placed under the frame for returning the plough to the starting point. The wheels of the truck are fixed on a right-angle lever in such a way that the traction of the horses lowers the wheels, lifting the plough (Fig. 21).

This plough costs £30 with the seat; £28 without the seat. In this case the hand-wheel for regulating is worked from the side as shown in Fig. 21.

Pelous' Horse-gin.

Pelous, an implement maker at Toulouse, endeavoured to remedy two of the inconveniences generally met with in horse-gins:—1st, the defect of want of stability and the tendency to tilting under the strain of the cable; 2nd, the defective winding of the cable on the drum.

Description.—It is composed of a winding drum 19½ inches in diameter, revolving round a vertical shaft, carrying a socket head, with two poles 11ft. 10in. in length. The motive power is multiplied by twelve. The machine can be mounted on wheels for shifting about. During work it is displaced on four rollers rolling on two rails. The machine is light. It only weighs 11cwt. 3qrs. To prevent tilting, Pelous places on the bed-plate two wooden cases of about 17½ cub. feet each in capacity, which are filled with earth; the additional weight is then 25cwt. 2qrs. to 29cwt. 2qrs. This is quite sufficient to insure the stability of the machine. When the work is finished the cases are emptied, and the weight to shift about is only 11cwt. 3qrs.

The cable, instead of winding freely round the drum, is guided by a small pulley fixed on an iron arm working with a slow up and down movement. This movement is given by means of a cam-wheel worked by means of a pinion. The cam makes one revoluti n for 23 revolutions of the drum; the guiding pulley rising during the first half revolution of the cam, and lowering during the second half. It is easy to conceive that the cable, guided in this way, will wind on the drum in a regular helix, all the turns being in perfect contact. This ingenious device, used for a very long time in the Fowler steam system, acts very well, on the condition that the cable be of an even diameter. If, on account of the wear and stress, the cable does not retain its original diameter, or, if a cable of a different diameter is used, the winding ceases to be regular. This cable guide, indispensable with the Fowler machines, which have large winding drums, and which impart a great speed to the cable, does not seem useful for horse-gins, which always have small drums, and work at a slow rate. It complicates the machine, and

increases its cost by £12. Up to the present no horse-gin has had this additional device, and, if the winding of the cable is not always very regular, this defect, however, is not of much importance. It is, as a matter of fact, easy to insure good winding. All that is necessary is to moderate the unwinding during the carrying back of the plough to the starting point, so as to prevent the last turns from becoming slack and overlapping one another. If this precaution is followed, defective winding never occurs.

The Pelous gin, with 274 yards of cable 0·6 inch in diameter, costs £32. With a cable guide, it costs £44. It hauls a strong trenching-plough, with a seat for the ploughman, which costs £28.

Working.—This machine works like those already described.

Mechanical Yield of Horse-Gins.

It is interesting to know the mechanical yield of gins—that is to say, to estimate the loss of power due to friction and other *detrimental resistance* of the machine, to find out the ratio between the moving power (horses) and the resistance (plough). Experiments were made by Chabaneix, of the School of Agriculture, Montpellier, in August, 1887, at Candillargues, with Beauquesne's gin.

The large traction *dynamometer* (power-gauge), of the School of Agriculture, was fixed to the bridle of the plough to measure the resistance offered by it. Another smaller dynamometer, belonging to the school, was interposed between the swingle-bar and the pole to measure the effort developed by the animals. The ratio between these two expresses the mechanical yield of the machine and the difference, the detrimental resistance. Two consecutive trials were made, and gave the following results:—

Detrimental resistance:

1st trial	... 11·8	per cent. of the total motive-power.
2nd ,,	... 10·3	,, ,, ,,
Mean	... 11	,,

Yield of the machine:

1st trial	... 88·2	per cent.
2nd ,,	... 89·7	,,
Mean	... 89·0	,,

These figures show that the yield of the machine is considerable, and the losses due to the mechanism almost

negligible ; in any case, they are much less than those resulting from the union of the animals in a single team executing the same work by direct traction on the plough.

Area Ploughed.

The surface ploughed per day with a horse-gin depends greatly on the length of the furrows and the size of the plot. It depends also on the experience of the workmen, and the skill with which they execute the different works. It may be approximately calculated as follows :—The horse at the pole travels at an average speed of 35½ inches per second, that is to say, 177 feet per minute. The length of the pole is generally to the diameter of the drum as 10 is to 1 ; the plough travels with a speed ten times less, that is to say, 17·7 feet per minute. If the width of the sod is 19½ inches, the surface ploughed will be 28·5 square feet per minute ; and for ploughing 4 poles it would require 37 minutes, without stoppage, interruption, or breakage. But, taking the plough back to the starting point, accidental stoppages, and unforeseen accidents, absorb a time equal to that usefully used for ploughing, so that one hour and fifteen minutes are usually required to plough 4 poles. In one day's work of ten hours an area of 32 poles can, therefore, be ploughed. With the movable gins, the conditions are more favorable, 4 poles per hour can be ploughed, that is to say, 40 poles per day. One cannot depend on more rapid work.

In shows and in public trials greater speeds have been attained ; but the work required from the men and animals was excessive, and could not be performed continuously.

Cost of Trenching or Subsoiling with Horse-gins.

The estimation of the cost comprises—1st, the interest on the outlay for plant ; 2nd, the expense for wear and tear ; 3rd, the daily expense of the work.

A trenching plant, gin, plough, and accessories, cost on the average, £80. This sum must be written off in ten years. Taking the interest on the capital at 5 per cent., the amount to be written off per annum is £10 10s. If we assume that we plough 12⅔ acres every year, and that we plough 40 poles every day, the machine will work 50 days in the year. The daily expense to be written off is $\frac{£10\ 10s.}{50}$ = 4s. 2d.

The wear and tear runs annually into 5 per cent. of the capital. That is to say, a daily expense of 1s. 7d. A driver for the horses, two ploughmen—one for the plough, the other for the pulley—a boy to drive the horse pulling the plough back to the starting point—such is the indispensable staff.

The daily expense incurred by this is:—

3 workmen, at 2s. 4½d.	...	7s. 1½d.
1 boy, at 1s. 2¼d. ...	...	1s. 2¼d.
3 horses, at 3s. 2d.	...	3s. 2d.
Total ...	...	11s. 5¾d.

This 11s. 5¾d., added to 4s. 2d. to be written off, to 1s. 7d. for wear and tear, bring the daily expense to 17s. 2¾d. As the area ploughed is 40 poles, the ploughing of 1 acre costs, roughly, £3 8s. 11d.

If the machine is worked less than 50 days in the year the cost per acre will be a little higher, for the sum to be written off yearly will be divided over a smaller number of days; if, on the contrary, the machine is worked a greater number of days, the price will be reduced.

STEAM WINDING DRUMS.

The same two classes may be established for steam drums. Some are stationary, that is to say, installed at the beginning of the work in a suitable place in the block till all the ploughing capable of being done with a certain length of cable is completed. Some are displacing, that is to say, gradually travel along a headland as the work proceeds.

In the first class we find the Beauquesne, Vernette, and Grué machines; in the second, those of Guyot, Pelous, and Pécard.

Beauquesne's Steam Winding Drum.

This was first placed on the market in 1887. It closely resembles his horse-gin.

Description.—A winding drum T (Fig. 22) revolves round a vertical shaft, carrying cogs on both its flanges, the upper one being smaller in diameter. Each of these cog-wheels gears with a pinion; the two pinions run loose on their shaft, but they may be alternately thrown into gear with a lever L. On the top of this shaft a bevel cog-wheel is keyed, gearing with a bevel pinion, fixed on a horizontal shaft

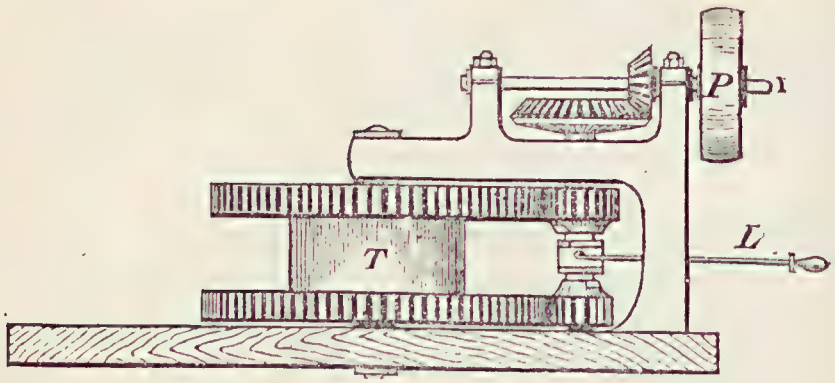

Fig. 22.—Beauquesne's Steam Winding Drum.

carrying a belt-pulley P. For shifting from one place to another, the machine may be mounted on wheels. When working, the wheels are removed, and the machine buried level with the bottom flange of the drum. The portable engine is fixed at a suitable distance, its pulley connected to the pulley of the drum by a belt.

Working.—The winding drum and the portable engine are usually installed in the middle of the headland. At one extremity of this headland a fixed pulley is anchored, the same as is used for the horse-gin. The drum of the capstan being disengaged, the cable is unwound, passed over the fixed pulley, and fastened to the plough, which is taken to the starting point. The portable engine is then started, the pinions thrown into gear, and the plough hauled. When it reaches the fixed pulley, the plough is thrown out of gear to lift it out of the ground, and is stopped by throwing the drum out of gear. The plough, placed on a trolley, is taken back to the starting point by a horse or pair of bullocks ; meanwhile the fixed pulley is displaced to an extent equal to the width of the furrow.

If the top pinion is thrown into gear, the drum revolves with greater speed, the plough travels quicker, but the traction decreases. If, on the contrary, the bottom pinion is thrown into gear, the speed diminishes while the traction increases. If the engine is powerful enough, the top pinion should be used. If not, the lower one.

We must notice that the engine does not work while the plough is taken back. This time is used by the engine-driver to raise the steam pressure, which, if the engine is not strong enough, might have diminished. One can therefore use a relatively small power engine, which would be insufficient if continuous work was required from it.

The capstan is constructed to work with an engine of 12 H.P., but it is generally worked with a 4 to 8 H.P. engine.

The cable may work in any direction. Therefore, one may, without displacing the machine, plough a block of 20 to 22½ acres with a cable 328 yards long. The headlands may be ploughed without shifting the plant. It suffices for this to anchor the fixed pulley in a suitable position. The non-ploughed headland on the engine side is 23 to 26 feet in width ; on the opposite side, 10 feet.

The plough is the same as used with the horse-gin ; it can work to a depth of 20 to 24 inches, turning a sod 20 inches wide.

The working of the plant requires three men—one engine-driver, one ploughman, one attendant—to manage the fixed pulley. A horse and a boy are also required to return the plough to the starting point. The capstan, with accessories, and 328 yards of cable, costs £160, plough excluded. The whole plant, plough, engine (6 to 7 H.P.), capstan, and accessories, costs £400.

Vernette's Steam Winding Drum.

Vernette builds two different types.

Description.—The first is simply his horse-gin, in which the pole socket-head is replaced by a toothed-wheel gearing with an endless screw, the shaft of which carries a pulley (Fig. 23). The supplementary mechanism is carried by a framework bolted on the bed-plate, and carrying the shaft through collars at the top. The cog-wheel and the drum are clamped by two cotters.

The second type resembles this, the only difference being that instead of an endless screw a pair of pinions are used to transmit the power. On the drum a bevel cog-wheel is keyed, gearing with a bevel pinion. On the shaft of the drum a cog-wheel is fixed, gearing with a pinion, on the shaft of which the pulley is fixed (Fig. 24).

This second type is preferable, the transmission by cogs giving a higher yield than that by endless screw.

They are both worked by connecting the pulley to the fly-wheel of the engine.

Working.—The capstan is placed on the ground, on its rollers, and fixed by a few pegs in such a position as to run

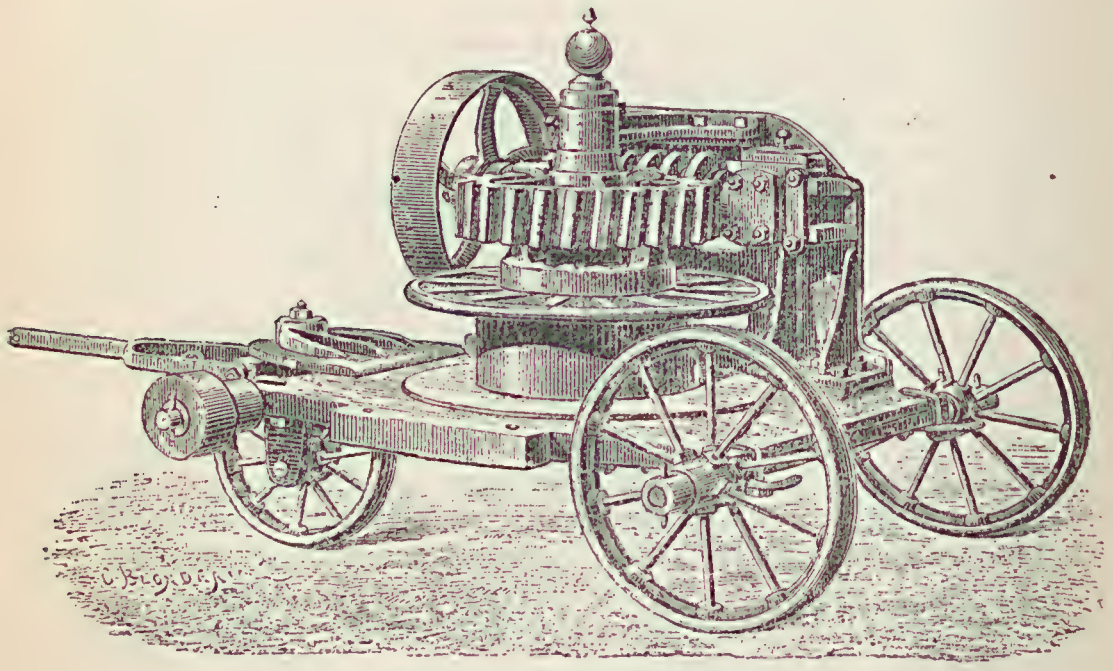

Fig. 23.—Vernette's Steam Winding Drum.

the furrow on the greater length of the block. The engine is placed in a suitable position, and connected by a belt generally 26 to 32 feet in length. The pulley is fixed on the opposite headland in the same way as for the Beauquesne machine.

The anchoring is done by means of iron pegs, disposed like an open fan at both ends of the anchoring chain, and

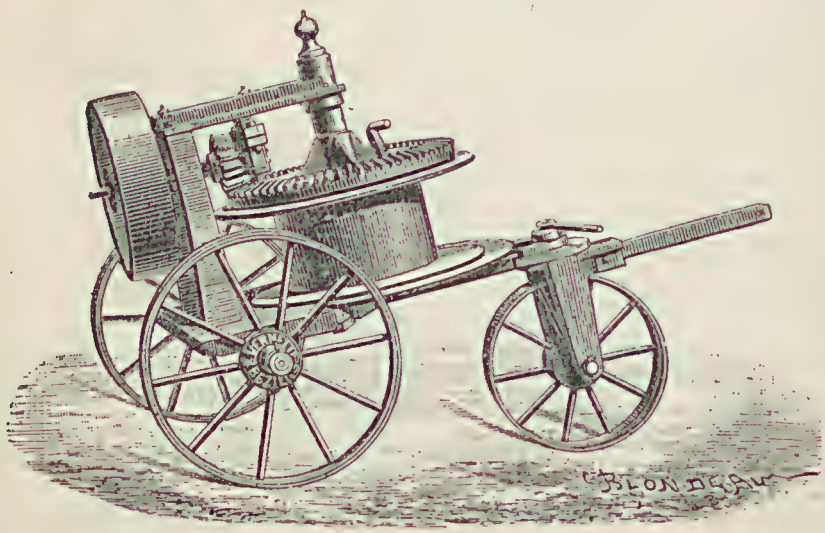

Fig. 24.—Second type of Vernette's Steam Winding Drum

joined to it by an iron bar. With an 8 H.P. engine working at 150 revolutions per minute the drum performs eight revolutions, and the cable travels at the rate of 69 feet per minute.

This machine is simple, strong, well constructed, and works satisfactorily; the only drawback is the difficulty of anchoring the fixed pulley.

Its cost is £92 without cable or plough. The cable, 0·55 inch in diameter, costs 4d. per foot; the plough, which is the same as for the horse-gin, costs £30. The whole plant, therefore, exclusive of the engine, costs £140. With an 8 H.P. engine costing £220 to £240, the whole plant costs £360 to £380.

Grué's Steam Winding Drum.

This machine can be used either with steam or horses. It is simply the machine shown in Fig. 10 (page 28), slightly modified.

Description.—The winding drum, T (Fig. 25) revolves round a vertical shaft, moved by a large cog-wheel A

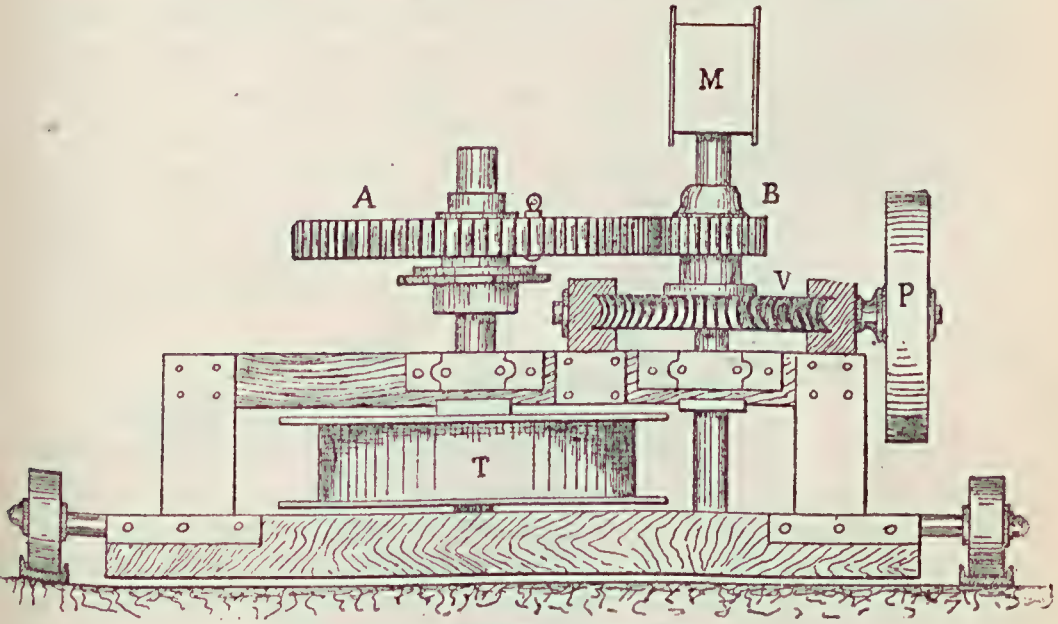

Fig. 25.—Grué's Steam Winding Drum.

gearing with a pinion B, on the shaft of which a pole socket-head M is keyed above; a cog-wheel V is keyed below, gearing with an endless horizontal screw, on the shaft of which the pulley P is fixed, which receives the belt of the engine. The large cog-wheel A is clamped to the drum by a cotter. The drum is allowed to run loose by lifting the cotter.

To work at a greater speed the endless screw and its cog-wheel may be fixed direct on the drum-shaft. In this case the machine resembles that of Vernette (Fig. 23). For medium depths, if the soil is light and if one has a powerful engine, the endless screw should be connected direct on the drum-shaft. If the motive power is small, and if the soil is stiff, and a greater depth of cultivation necessary, the endless screw should be connected to the pole-socket shaft as shown in the figure. If it is desired to work with horses, the endless screw is removed, and the machine worked like an ordinary horse-gin. The winding drum travels along the headland on its rollers. The engine connected by the belt follows it. It can also be used in a fixed position.

Working.—When this winding drum is worked with an engine, it is preferable to install it in a stationary position, the cable passing over a fixed pulley. The frequent displacements of the engine necessitated entail considerable loss of time. With animals, on the contrary, the displacement can be quickly done.

The only interesting peculiarity of this machine is the adjustability of the speeds it is worked at, according to the motive power, the state of the land, and the depth to be ploughed. This adjustment of speed, the utility of which is not apparent when horses are used, is, on the contrary, an excellent item when steam-power is used, on account of the varied power of engines. It is evidently important to work rapidly when one has a 8 to 12 H.P. engine, and also to be able to work the machine with an engine of 3 to 4 H.P. only if necessary.

Guyot's Steam Winding Drum.

The Guyot steam winding drum is a displacement capstan, worked in a very ingenious manner. The portable engine and the drum are carried on two strong iron beams, the whole plant travelling on rails. The stability, therefore, is very great, as the whole weight of the engine and drum is opposed to the traction of the cable. The lateral displacement is also rendered very easy.

Description.—The wheels of the portable engine rest on two rolled joist girders, braced together at the required distance apart. The capstan is fixed in front ; it consists of a mechanical drum (Fig. 26), on the shaft of which a cog-wheel is keyed, gearing with a pinion, on the shaft of which

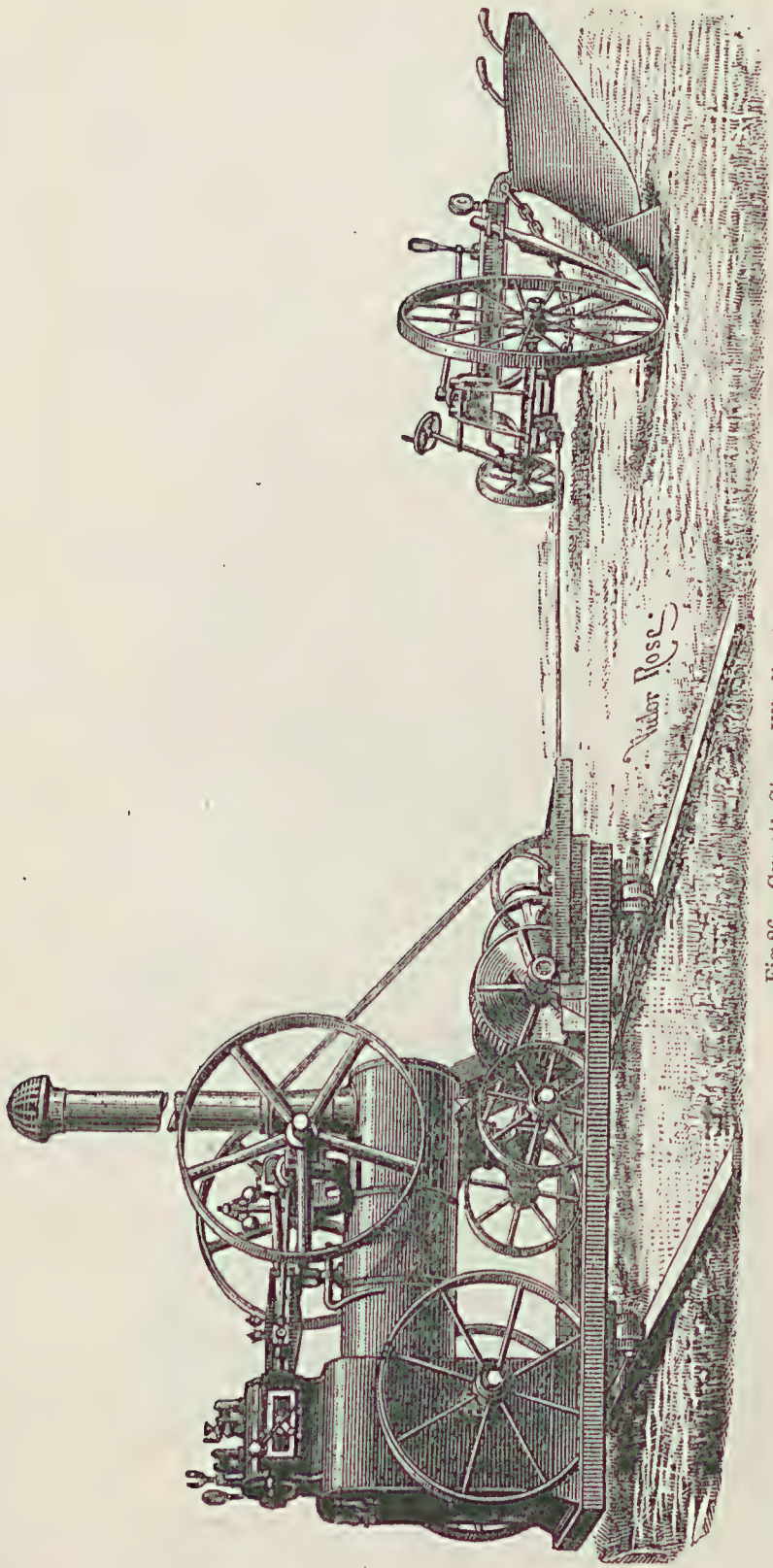

Fig 26.—Guyot's Steam Winding Drum.

a cog-wheel is fixed, gearing with a second pinion, keyed on the shaft which carries the pulley; this is connected by a belt to the pulley of the engine. The two machines, therefore, form one. The iron frame rests on rollers, rolling on rolled joist girders. The tires of these rollers are perforated with holes in which levers are engaged for displacing the system. The axles of the rollers may move obliquely to allow the system to be displaced easily on a curved or sinuous headland. When the end of the block is reached, it is easy by turning it at 90° to plough the headland. In this case special curved rails are used. A brake to control the unwinding, and a gearing lever complete the machine. The model exhibited at the Perpignan Show had, in addition, an arrangement allowing the plough to be hauled back to the starting point. For this purpose the intermediate shaft had a small drum keyed on to it, on which a thinner cable was wound. This, after passing over the fixed pulley, was tied to the rear of the plough. A lever threw it in or out of gear.

Working.—The working of this system is very simple; the frame carrying the engine and capstan is installed on the shortest headland. The thinner cable fastened to the rear of the plough hauls it to the opposite headland. When the plough reaches it, the small drum is thrown out of gear; this throws the large drum into gear, and the plough is hauled. When the plough reaches the system the small drum is thrown into gear, hauling it back to the starting point, and so forth.

In the meantime the system has been displaced laterally.

The fixed pulley and the small cable runner are indispensable to guide the cable. Their anchoring, however, is simple, for they have only a small effort to sustain. The pulley and runner may be displaced during work without waste of time. The non-ploughed headland on the engine side is 39 feet in width; on the opposite side, 10 feet.

The plough is the same as that used with the Guyot horse-gin. With an 8 H.P. engine working at 140 revolutions the plough travels at a rate of 59 feet per minute.

Three men are required for the working; one engine-driver, one to work the capstan, and another to work the plough. If the small drum is used, another man is required to shift the runner and the fixed pulley, in the other case a horse and a boy.

This machine works perfectly; its management is simple, and the loss of time is reduced to a minimum. Only the

setting up and dismantling are somewhat difficult, on account of the weight of the pieces to be moved. To haul the machine on the frame, the capstan is fixed to one end of it, the cable fastened to the forecarriage of the engine, and worked by hand; it takes twenty minutes to mount in position; the setting up of the whole machine takes two hours. For shifting; the frame, capstan, and accessories are removed on an ordinary dray. The weight of frame and capstan is 2 tons 8 cwt. Its cost, without either cable or plough, is £112. With cable and plough, the plant costs £134; with small extra winding drum, £176. The cost of the whole plant, with an 8 H.P. engine, costing £240, is £392. With a fixed pulley and the runner it reaches £416.

Pelous' Steam Winding Drum.

Resembles that just described, but has three interesting additions. First, it can work both ways; second, the winding of the cables is guided by a special device; third, the lateral displacement of the system is done automatically,

Description.—As in the Guyot system, the engine and capstan rest on a large strong frame made of rolled joist girders. The capstan is double. That is to say, made of two drums, each worked by a pair of cog-wheels. To each drum an endless screw is geared, working a lever guiding the winding of the cable. The throwing in or out of gear of the drum is done by friction, which renders the throwing out of gear easy whatever the traction effort be. It also serves as a break during the unwinding. The large frame rests on four rollers, rolling on iron rails; two of them are geared with an endless screw allowing their automatic displacement. On the opposite headland a pulley is fixed to an automatic anchor made of a truck travelling laterally, the stability of which is secured by a case 141 cubic feet in capacity, which is filled with earth. The lateral displacement of this truck on the headland takes place on rails, and is obtained by means of an endless screw and a cog-wheel; one turn of the screw corresponds to a displacement of 2 inches.

The Bajac balance-plough, shown in Fig. 27, is used; it is made entirely of steel, and possesses great strength.

The depth is obtained by means of two screws placed on each side of the forecarriage. The frames of the two ploughs are united together by a strong steel bar, which renders the system very rigid. The beam can be displaced

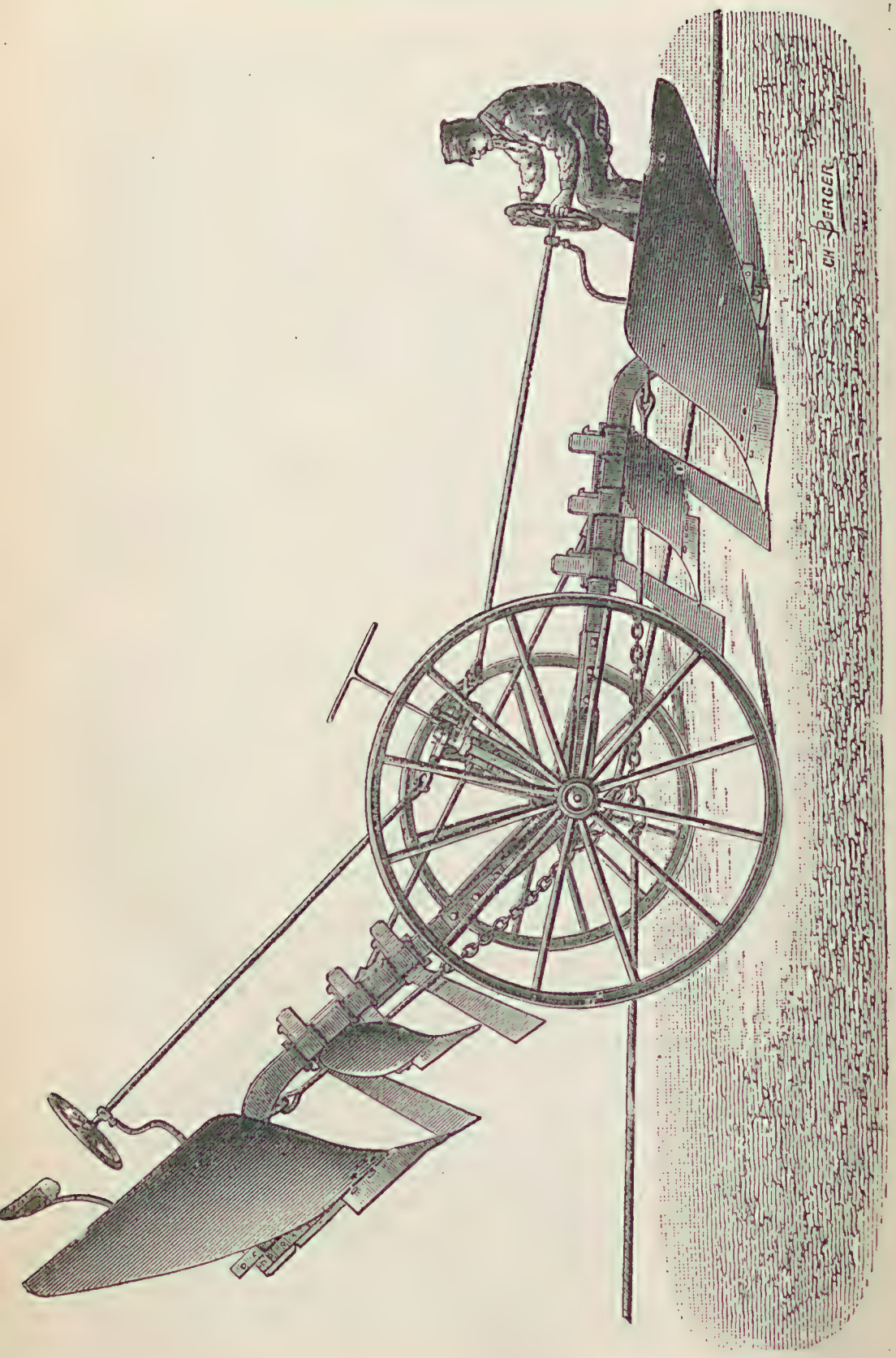

Fig. 27.—Bajac's Balance-plough.

laterally on the forecarriage, according to the width of the sod to be turned; during the work the ploughman guides the plough by altering the angle of the wheel axle on the beam. The traction of the cable is regulated by a hook which can be displaced on the forecarriage. This plough is connected to the capstan by two cables; one is 328 yards in length, and 0·7 inch in diameter, and hauls the plough directly; the other, which is 656 yards long and 0·74 inch in diameter passes over the automatic anchor and is wound round the second drum.

Working.—This machine is easily managed; the system is installed on one side of the block, the pulley on the other. Each of the drums are thrown into gear alternately, the winding of the cables causing the plough to travel backwards and forwards, the system being displaced the necessary distance before each furrow. Four men are required; one rides the plough, one works the pulley, two attend to the steam winding drum.

With a 12 H.P. engine working at 180 revolutions the plough travels at the rate of 88 feet per minute.

The non-ploughed headland on the engine side is 43 to 46 feet wide; on the opposite side, 20 feet. To plough the headland, the automatic anchor has to be carried from one end of the block to the other; this is a tedious operation.

This winding drum weighs 3 tons 10 cwt., and costs £240, cable included. The plough costs £80. With an engine of 10 H.P., costing £300, the whole plant involves an outlay of £620.

Pelous' plant is well studied in all its details, and strongly constructed. We may wonder, however, if its high cost and expensive working are justified in face of the rate of work, and if the two improvements are really practically useful. The calculation of the cost of working per acre in the case of winding drums working one way, as will be explained later on, shows on which side the advantage lies. We see the area ploughed every year must be at least 80 acres for the double-effect drum to be more economic than the single-effect drum. Therefore it is only suited for contractors.

The usefulness of the winding guides is questionable; without them the winding is fairly regular, and accidents are rare enough to justify discarding this unnecessary complication.

It should be noticed that this device only works well while the cable is new, and retains the diameter for which the winding guide was made. If the wear or the natural lengthening of the cable diminishes its diameter, the winding is more defective than if there were no guide.

Finally, the automatic displacement of the system, which is very ingenious indeed, does not seem to be very useful. Its mechanism is complicated, and its management requires a prudent and skilful man to prevent the system becoming derailed. And what is more, the two rollers being fixed on the same shaft, renders it impossible for the machine to travel obliquely.*

The machine could therefore be simplified with advantage. Transformed into a simple effect drum, the complicated mechanism being removed, but the details of construction being preserved, this machine would be more favoured by growers than the double effect machine exhibited at the Perpignan Show in 1890.

Pécard Bros.' Steam Winding Drum.

Messrs. Pécard Bros., of Nevers, construct a machine having a certain analogy to that of Guyot. Engine and drum are carried on a strong frame. There is a large drum for the traction cable, and a small one for taking the plough back to the starting point, the only differences being that different speeds can be obtained and that the lateral displacement of the system is automatic, as in the case of Pelous' winding drum.

Description.—The portable engine, 7 to 8 H.P. generally, is carried by a strong frame on which the capstan is bolted (Fig. 28). The system is carried by six rollers running on rails. The fly-wheel of the engine is connected by a cross-belt to the pulley of the drum, which has a double cog-wheel gearing. Two levers enable the combination of the cog-wheels to be modified and four different speeds obtained. One of these levers also serves to disconnect the large drum. A small drum running at two speeds is keyed on the intermediate shaft.

The automatic displacement of the system is effected by another cross-belt passing over the small fly-wheel of the engine. A double cog-wheel gearing with an endless screw

* This is comparatively unimportant in Victoria, as the blocks are generally rectangular. (Trans.)

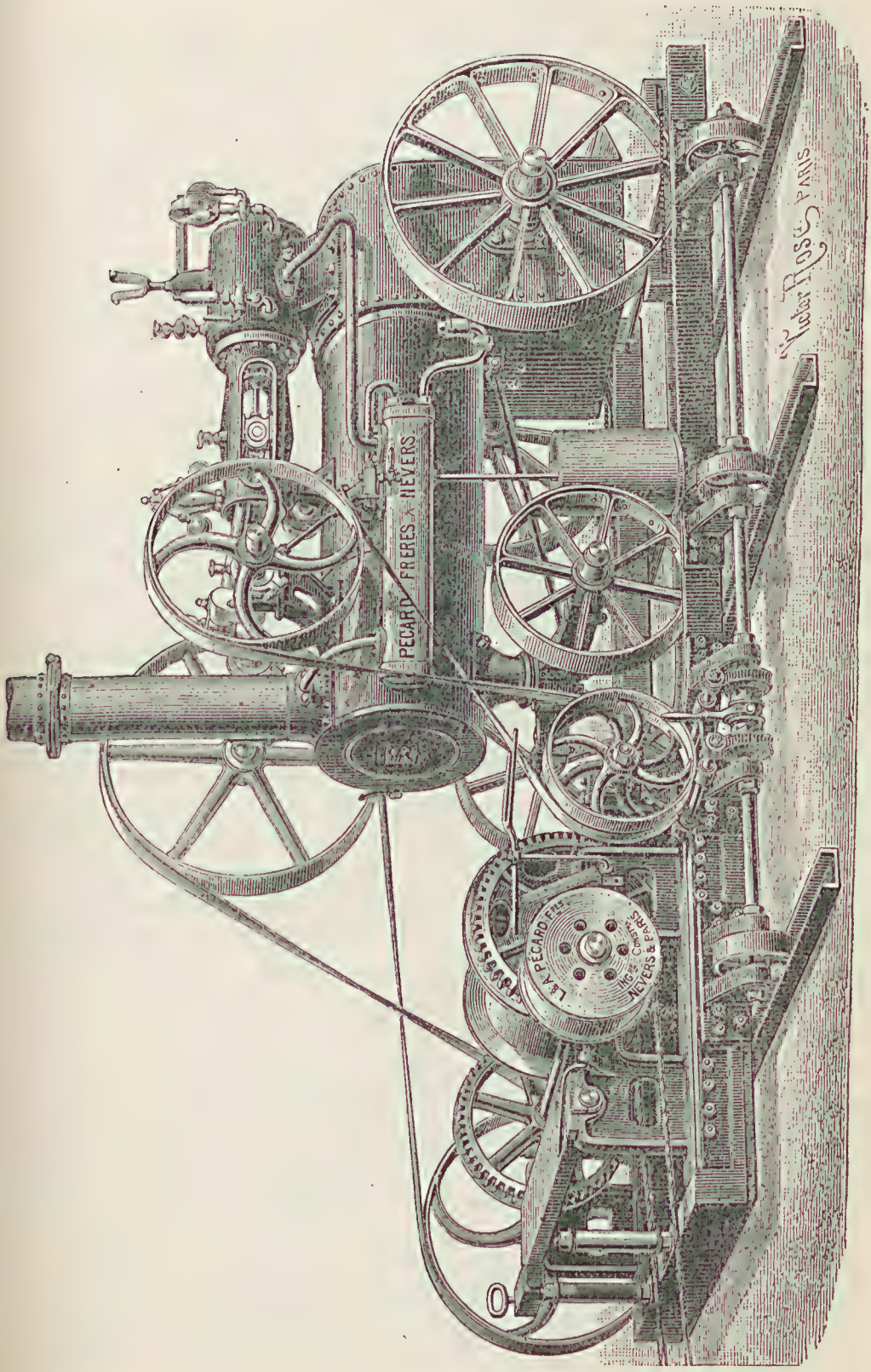

Fig. 28.—Pécard's Steam Winding Drum.

allows it to be displaced backwards or forwards. After each displacement the belt is shifted on to a loose pulley. The system is installed on one of the headlands, and the plough fastened to the large cable. The small cable, known as the returning cable, is made fast to the rear of the plough, after passing over the fixed pulley anchored on the opposite headland. When everything is in place, the small drum being thrown into gear, the plough is pulled backwards to the starting point. The large drum is then thrown into gear, and one of the four speeds applied according to the soil and the depth of ploughing. When the plough reaches the end of the furrow the large drum is thrown out of gear, and the small one thrown into gear, the plough hauled back, and so forth. In the meantime, the system has been displaced automatically.

With a 6 H.P. engine, working at 150 revolutions per minute, a plough is hauled at a rate of 58ft. 4in., 68ft. 10in., 82ft. or 96ft. 8in. per minute. The plough is hauled back at a rate of 164 feet to 197 feet per minute, as the case may be.

Four men at least are required for the management of this outfit—two for the capstan and engine, one to ride the plough, and one to attend to the automatic anchor and the cable runner.

Pécard Bros.' device is undoubtedly one of the most ingenious. But it is more complicated than that of Guyot, and would be advantageously simplified by doing away with the automatic displacement of the large frame engine. This mechanism is not only useless but also cumbersome, for it is impossible to work in any other but a straight line, and cannot be turned round at the completion of the work in order to plough the headlands. Its cost, exclusive of engine and plough, is £100.

Pineau's Steam Winding Drum.

At the Agricultural Show held at Avignon in 1891, a steam winding drum was exhibited, constructed by Pineau, of Moulins (Allier), designed after the well-known style of Howard.

Description.—The portable engine is fixed in a set position in the middle of the headland. The capstan, made of two drums, revolved by two pairs of cog-wheels, is carried by a truck, the shafts of which are tied to the rear of the

engine. A platform is fixed on the shafts for the engine-driver and the fuel. The capstan is connected to the engine by means of a belt.

The extremities of a cable, which travels all round the block to be ploughed, are fixed one to each drum.

Fixed pulleys, anchored in suitable positions, carry the cable. A gearing device enables the engine-driver to alternately throw either drum into gear. The plough, being fastened in the middle of the cable, is therefore hauled backwards and forwards. It is a balance plough. At each furrow the two end pulleys are displaced for a distance equal to the width of the furrow.

To facilitate this displacement, these pulleys are carried on automatic anchor-trucks, similar to those of the Fowler system. These anchor-trucks are mounted on discs of iron with sharp tires, penetrating the soil on account of the load. The anchor resists well any traction perpendicular to the plane of the discs, while movement in the direction of the discs offers only slight difficulty. To obtain the necessary translatory movement of the anchor, a small cable is fastened at one end to a fixed point, an old stump or post for instance, the other winding round a small capstan carried by the anchor-truck. While the plough is travelling away from the anchor, the small cable is slackened a little, and as soon as the engine begins to pull the plough forward, the anchor-truck rolls on its discs, and moves a distance equal to the length slackened by the small cable. The moving of the anchor truck is therefore done automatically without any waste of time.

Working.—The plough opens furrows parallel to the headland where the engine is fixed, the work beginning on the opposite headland. At the start, the cable completely hems round the block; as the work progresses the rectangle formed by the cable gradually diminishes. The plough travels at a rate depending on the power of the engine, the nature of the soil, the depth of the ploughing, &c. This rate may reach 118 feet per minute, but is generally from 82 feet to 98 feet.

One engine-driver is sufficient to attend to the engine and capstan. Three men are required to attend to the plough and anchor-trucks.

The whole plant costs £532.

The working of the machine is satisfactory. The anchoring of the two fixed pulleys, which are not carried by anchor-trucks, is the only difficulty. Anchoring-plates, as already described, give the best results.

Mechanical Yield of Steam Winding Drums.

There is no definite record published on the mechanical yield of steam capstans. However, we may estimate it approximately by comparison with ordinary horse-gins. The only mechanism interposed between the motive power and the resistance is one or two pairs of cog-wheels, as in the case of horse-gins.

Numerous dynamometric trials made on horse-gins have shown that the yield varies between 70 and 80 per cent., and that in the case of a gin provided with two pairs of cog-wheels the yield is 75 per cent. This figure can be regarded as the yield of steam winding drums.

Area Ploughed.

As in the case of horse-gins, the area ploughed daily varies greatly, and depends on the length of the furrow, the size of the block, the motive power, the experience and skill of the workmen, also according to whether it is a simple or double effect capstan. If we assume an average rate of travelling of the cable of 65ft. 7in. per minute, and a sod 19·7 inches wide, the area ploughed in one minute is 107·6 square feet. Seven hours are required to plough 1 acre, assuming that there is no interruption. But the hauling back of the plough (simple-effect capstan), unforeseen accidents, ploughing of the headlands, reduce this area to half. Therefore 14 hours are required to plough 1 acre, that is to say, about one day and a half, assuming that we work ten hours a day.

With a displacement capstan, Guyot or Pécard, for instance, and with a powerful engine it is possible to work one acre per day. But it is safer to reckon on one and a quarter days.

With a double-effect capstan, Pelous or Pineau, for instance, the work is more rapid. The cable travels at the rate of 88ft. 6in. per minute, ploughs 145 square feet per minute, or 966 square yards per hour. Assuming that one-third of the time is wasted, this means an area of 240 poles per day of ten hours. One acre may therefore be worked in 6 hours 40 minutes.

If we take into account the installation of the plant, it is far safer to reckon on one day per acre.

Cost of Trenching or Subsoiling with Steam Winding Drums.

Three forms of expenditure must be taken into consideration.

1st. The writing off of the cost of the plant.
2nd. The wear and tear.
3rd. The daily cost of the work.

A.—Simple-effect Plant.

Average cost £400. This capital is to be written off in eight years. If we assume that we plough 80 poles per day, and work 60 days in the year, we arrive at the following:—

	Per Annum. £
Writing off and interest at 5 per cent. of £400 in eight years	71
Wear and tear of material at 3 per cent. of the capital	12
Total ...	£83

Equal to £1 7s. 4d. per day.

The daily expenditure is reckoned as follows :—

	£	s.	d.
One engine-driver	0	4	9
Two men	0	4	9
One horse and one boy	0	4	0
One pair bullocks and driver for carrying water and fuel ...	0	4	9
6cwt. 1qr. 6lbs. of coal (8·8 lbs. per horse-power hour for an engine of 8 horse-power working ten hours), at 18s. per ton	0	5	8
Oil, cotton-waste, putty, &c. ...	0	1	7
Total ...	1	5	6
Plus writing off wear and tear ...	1	7	4
Daily expenditure ...	£2	12	10

Which brings the cost of ploughing 1 acre to £3 7s. 5d.

B. Double-effect Plant.

Average cost, £600. This capital to be written off in the same number of years, and the same rate of interest. If we assume we plough 80 poles per day, and work 40 days in the year, we arrive at the following :—

	Per Annum. £	s.	d.
Writing off and interest at 5 per cent. of £600 in eight years	105	0	0
Wear and tear of material at 3 per cent. of the capital	18	0	0
Total	£123	0	0

Equal to £3 1s. 6d. per day.

The daily expenditure is reckoned as follows :—

	£	s.	d.
One engine-driver	0	4	9
Three workmen, at 2s. 4d.... ...	0	7	0
Pair bullocks and driver	0	4	9
7cwt. 3qrs. 14lbs. coal (8·8 lbs. per h.p. hour for a 10 h.p. engine working 10 hours), at 18s. per ton ...	0	7	0
Oil, cotton waste, putty, &c. ...	0	2	0
Total	1	5	6
Plus writing off wear and tear ...	3	1	6
Daily expenditure	£4	7	0

Which brings the cost of ploughing one acre to £3 9s. 7d.

We see that for a small grower who does not trench or subsoil more than 50 acres each year the simple-effect plant is more economical than the double effect. In order to derive advantage from the latter we must plough annually at least 72 acres; for an area of 70 acres, the cost is equal in both systems—£2 14s. 5d. per acre.

It is interesting to ascertain for what area yearly ploughed it is justifiable to use steam-power.

Assuming that we require two days to plough ½ acre with a horse-gin, and that the same work can be done by steam in ⅔ day, we see that for an area under 30 acres per annum the advantage lies on the side of the horse-gin, and for an area exceeding 30 acres it falls to the side of the steam-power. The cost of one acre in this case comes to £4 1s. 7d.

The advantages are in favour of steam power for a lesser area, if a portable engine is already in use for other work on the farm, and worked a greater number of days, as in this case the writing off of the capital and the wear and tear is spread over a greater number of days. This is generally the case.

Steam-power is therefore always cheaper when there is an engine on the farm.

Independently of the question of economy, which makes us favour steam-power applied to simple-effect in preference to double-effect capstans, we must also take the power of the engine into consideration. If it is under 8 H.P., it could not work, without stoppages, a plough working at a depth of 20 inches. With a simple-effect drum, the pressure is regained while the plough is being hauled back into position. The engine can, therefore, perform in an intermittent way, work that it could not do continuously.

In conclusion, experience teaches us that it is possible, with capstans driven either by steam or horse power, to do deep ploughing impossible with ordinary teams, and at a cost so much the less as the area to be ploughed is larger, and always at a cost below £4 16s. per acre.

For small growers who cannot spare the capital necessary for the purchase of the plant, and for those who do not possess an area large enough to justify the buying of such machinery, the hiring of it becomes advisable, and many contractors are nowadays ready to undertake the work at reasonable prices. Many are already at work, and it is to be hoped that this number will increase. They are called upon to render great services to small growers, especially in viticultural regions which have been unfortunately invaded by the phylloxera.

II.

APPLIANCES FOR TRENCHING AND SUBSOILING.*

By Max Ringelmann,

Professor at the National Agricultural Institute, Paris.

At the beginning of the nineteenth century, agriculturists were convinced of the need of deep cultivation for the improvement of land for certain special cultures, that of madder for instance, but the difficulty of execution of deep ploughing resided in the defective making of trenching or subsoiling ploughs, as well as in the great number of animals required for this work. In 1852 the improvements made in iron implement construction generally, enabled Vallerand to initiate sugar-beet culture by disturbing the land to a depth of 14 inches, a depth which was very soon increased when the Bonnet plough appeared on the market. This improvement of the land tended to become general towards 1855, while active polemics took place between the partisans of trenching (bringing the subsoil to the surface) and those advocating subsoiling (disturbing the subsoil *in situ*). The latter had an advantage over the former in being able to use lighter implements, which it was easier to construct strongly at that time.

The manufacture of agricultural implements made very rapid advances between 1865 and 1880, owing to developments in the metallurgy of iron, and, above all, the substitution of steel for iron, enabled the construction of much more powerful instruments than that of Vallerand. A reaction then took place, the subsoilers were discarded, and the trenching plough gained the ascendancy.

Agriculturists were then in possession of powerful ploughs, but could rarely spare the necessary draught ; for this reason the use of these implements was very limited. The viticulturists of the South of France, convinced of the possibility of reconstituting their vineyards with American vines, and of the necessity of deep cultivation prior to planting these vines,

* *Journal d'Agriculture Pratique*, Vol. 64. 1900.

asked implement makers to devise a system which would enable them to perform deep cultivation with two to four animals only, during the slack season. Naturally, they were ready to give more time to the operation, this question being only of secondary importance, considering that a permanent improvement of the soil was required, and not a merely annual ploughing. Then in the year 1882 the construction of horse-gins applied to the hauling of ploughs was first attempted; a few years later these machines were used with success to clear and throw into culture Algerian plains, other colonies following this example.

To solve the problem, a motor, consisting of a capstan, was interposed between the plough and the team.

Any animal furnishes its maximum power when it is required to exert a certain effort F, at a certain rate V.

To give an example, we quote the following figures resulting from a large number of trials :—

Weight of the Animals.	Mean Effort Exerted.	Rate per Second.
	Horse.	
660 to 990 lbs. ...	143 to 154 lbs. ...	27·5in. to 29·5in.
990 to 1,320 lbs. ...	198 to 242 lbs. ...	25·5in. to 27·5in.
1,320 to 1,760 lbs. ...	264 to 330 lbs. ...	23·6in. to 25·5in.
	Bullock.	
550 to 880 lbs. ...	121 to 154 lbs. ...	27·5in. to 29·5in.
880 to 1,110 lbs. ...	198 to 242 lbs. ...	23·6in. to 25·5in.
1,110 to 1,540 lbs. ...	352 to 440 lbs. ...	19·6in. to 21·5in.

These figures correspond to a period of useful work of 45 minutes per hour, and an average duration of eight hours' work per day (360 to 400 minutes per day). When several animals are yoked together the mean effort diminishes, for the animals never pull simultaneously. The walking pace we may represent by the following figures, the useful effort furnished by each animal when yoked together with others*:—

* As an example of this in practice, let us assume a horse working alone furnishing a mean effort of 198 lbs.; the effort of a pair will then be 198 × 2 × 0·93 = 368·2 lbs. The effort of four animals working abreast will be 367·4 lbs. × 2 × 0·93 = 683·3 lbs., while if the animals are yoked in tandem we will only have 198 lbs. × 4 × 0·75 = 594 lbs. Assuming a bullock exerting a mean effort of 220 lbs., two bullocks abreast will give 220 lbs. × 2 × 0·93 = 409·2 lbs.; two pairs will furnish a mean effort of 409·2 lbs. × 2 × 0·93 = 761 lbs.

Number of animals per team.	Useful effort exerted by each animal (ratio).
1	1·00
2	0·93
3	0·85
4	0·77
5	0·70
6	0·63
7	0·56
8	0·49

Animals furnish per second mechanical work T given by the formula:—

$$T = FV.$$

But we cannot compel them to give us *equivalent mechanical work** as, for instance, to furnish us with an effort three times greater with three times less speed. In other words, we cannot apply the following formula:—

$$FV = 3F\frac{V}{3} = 10F\frac{V}{10} = \ldots\ldots$$

which is possible with other motors. For one must observe a relation between the frequence of the movements of the skeleton and those of the movements of the heart; thus, a man having sixteen respiratory movements per minute, can only work a handle at the rate of 16, 32, 48, 56 revolutions per minute, or strike 8, 16, 24, 32 blows with a hammer. Experience shows that when this concordance is not observed, breathlessness occurs, the animated motor becomes fatigued and quickly succumbs.

In the application we are considering now, the resistance of the implement is diminished by means of an intermediate mechanism, in order to work the animal at its most favorable speed. This mechanism will absorb a part of the effort for its own work.

If k is the yield of the mechanism,
F the effort of the animal,
V its mean speed,
n a fixed co-efficient, greater than unity, we may write:—

$$FV\,k = nF\frac{V}{n}.$$

* See *Traité de mécanique expérimentale*, p. 141; Librairie Agricole.

nF is the resistance to be overcome, that is to say the traction of the plough which we may designate as R;

$\frac{V}{n}$ is the speed of this resistance, which we may designate by v, and we may write :—

$$FV\,k = R\,v.$$

Let us notice that we lose a certain quantity of motive power F × V, for the co-efficient k is less than unity, but the intermediate mechanism offers the enormous practical advantage of enabling us to obtain, with the most advantageous speed of the animal, a traction R of the plough as high as is desired, on the condition, however, of diminishing the speed v of the latter proportionately. We may recall the popular expression—"*What is gained in power is lost in speed.*"

The mechanism used may be a gearing winding drum or a capstan.

According to Ferrouillat, Desforges relates.* (See page 18.)

J. C. Loudon (*Encyclopedia of Agriculture*, 1831) mentions a mole-plough invented by Adam Scott, and improved by Lumbert, of Gloucestershire ; this implement, penetrating very deeply into the soil, was hauled by a capstan worked by four men or by a horse.

The capstan was improved by Weir, of Oxford-street, London. The figure in Loudon's work gives a fairly accurate idea of those in actual use.† We give, on account of its historical interest, the Fig. 29, which shows one of these capstans hauling a mole-plough.

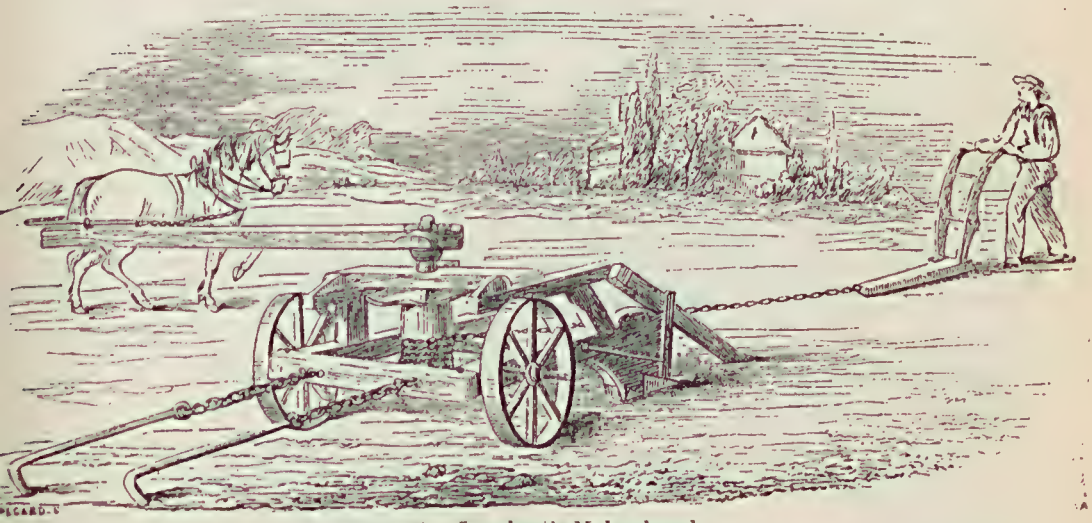

Fig. 29.—Lumbert's Mole-plough.

* *Rapport sur le concours special de treuils à Narbonne*, 1888.

† See *Loudon's Encyclopedia of Agriculture*, 8th edition, 1883, page 401.

De Gasparin* mentions the plough (Fig. 30) and capstan of Bierley, travelling at a speed of 1·36 in. per second, under a hauling traction of 13 cwt. 3 qrs. The

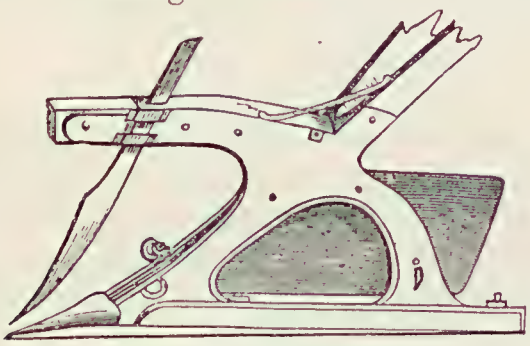

Fig. 30.—Bierley's Plough.

plough was reduced to its simplest form, the wire cable being fastened to the front of the body. De Gasparin says:—"We have also seen ploughs and capstans used for the uprooting of madder; a donkey or a weak horse opened a furrow, which would have needed a team of 24 horses; a cable winding round a drum increased the force of the traction, but proportionately increased the time necessary to perform the work. A furrow of 526 feet only was opened in one hour, and after each furrow a great deal of time was wasted in returning the plough to the starting point. The cost was half that done by hand, but four days were required to plough 1 acre, which 24 horses would have ploughed in twelve hours for the same cost.

"In 1841 Georges worked a horse-gin with a Dombasle plough. He is reported to have ploughed three parallel furrows 52 feet in length, $8\frac{1}{2}$ inches in width and depth, in eighteen minutes. Six men worked the capstan alternately; it was 4ft. 11in. in diameter; the men worked levers 10ft. 9in. in length. The resistance of the plough must have been 454 lbs., equivalent to four ordinary horses, which could have ploughed $\frac{3}{4}$ acre in eight hours.† To estimate the cost of the two operations it suffices to compare 32 hours for one horse, as against 372 hours for one man. But if, instead of six men, one horse had been used, we see that the mechanism of the capstan would have caused a loss of half the strength used."

De Gasparin only studied this system as applied to yearly cultural operations, and not from the point of view of the permanent improvement of the land, which explains his inference.

* *Cours d'Agriculture*, vol. iii., p. 155.
† Laur, *Culture de la Garance.*

In England various capstans have been used for drainage (Pearson's system worked by hand),* amongst which we may mention Fowler and Fry's machine.† Fig. 31 shows Fowler

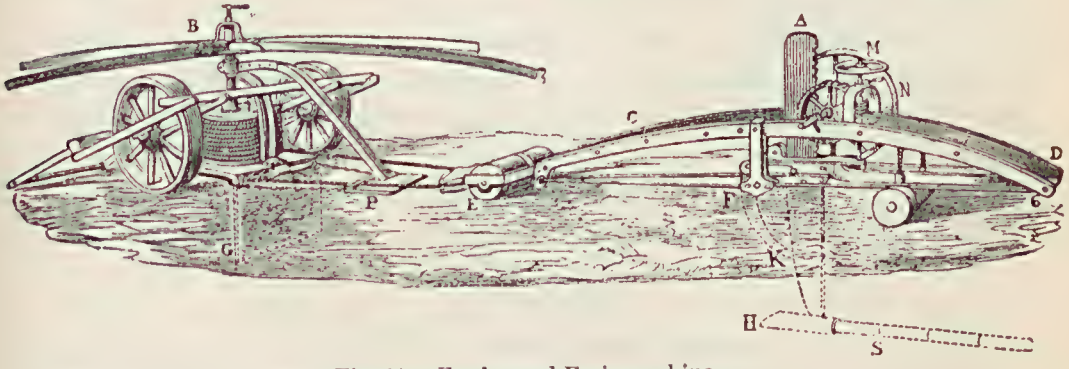

Fig. 31.—Fowler and Fry's machine.

and Fry's capstan B and their mole-plough A, which are not within the scope of the present study. The capstan being anchored to plate G, and resting on a shoe P, two to four horses are yoked to it. In 1855 Fowler used a 6 to 8 H.P. engine to work this capstan, and an official trial of it was made on the 7th June, 1856, near the Trianon (Paris), in presence of an international jury.

Trenching and subsoiling with the aid of a steam-winding drum was undertaken near Gand in 1877, with a view of applying them to the stiff soils (polders of Zealand).‡

After these few attempts, capstans seem to have been forgotten, till the reconstitution of vineyards in the South of France reintroduced the question of deep ploughing. At first the ploughs were hauled by teams of often more than ten horses, then hauling engines were used (Fowler), but these were too costly to come into general use, and vine-growers were on the look-out for a system to enable them to economically trench or subsoil small areas.

In 1876 Léonce Grué, of Beaulieu, near Solliès-Pont (Var), used a horse-gin worked by two horses, formed of a winding drum, hauling the plough by means of a steel rope. Bourguignon following his idea, constructed the Valessie system in 1887.§

While the South of France was greatly preoccupied by the reconstitution of their vineyards and the deep cultivation

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* *Trans. of the Soc. Arts*, 1829. Pearson's method of pipe draining.

† *Rapport général de Pusey, sur les instruments agricoles à l'exposition universelle de Londres*, 1851.

‡ *Défoncements et sous-solages à vapeur.* G. Scribe ; *Journal d'Agriculture pratique*, 1877, vol. 1. p. 829.

§ Bourguignon constructed the first capstan of Grué.

necessitated, our colleague, P. Ferrouillat, then Professor of Agricultural Engineering at the National School of Agriculture, Montpellier, expressed the following views in the Progrès Agricole of 1891 (see page 63).

In 1888, a special competitive show of capstans was held at Narbonne. More than one hundred were then in use in the South of France for the preparation of land for reconstitution purposes. In 1890 another competitive show was held at Perpignan. The widespread use of these machines in the South of France and Algeria dates from that time.

Horse-gins.

Horse-gins* consist essentially of a drum or cylinder, A (Fig. 32), revolving round a vertical axle *a*. The horse M is yoked at the end of a pole L, to which the bridle is

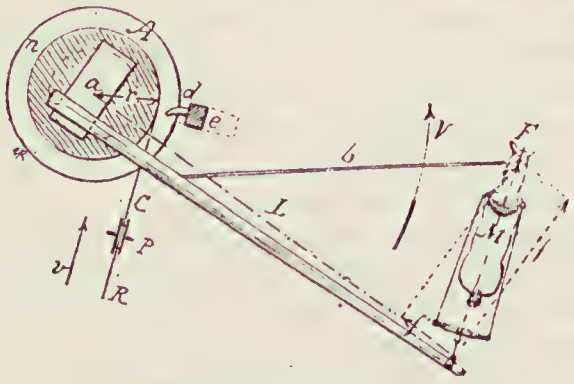


Fig. 32.—Diagram of a Horse-gin.

also connected by a wooden rod *b*. When the pole is clamped on the drum by means of cotters or pins the horse in his movement revolves the drum which winds the cable C, at the extremity of which the plough is fastened. The motor M, exerts a mean effort F, a part of which *f*, only is utilized; the latter being the projection of the effort F on the perpendicular to the radius passing by the yoking hook,† the other component *f'*, simply increases the pressure of the drum on its axle. It is, therefore, advisable to diminish *f'* (prejudicial force), and increase *f* (useful force), by giving the greatest possible length to the pole. In practice it does not exceed 16½ feet.

For heavy work, instead of using a single horse, two or six may be yoked to corresponding poles fixed in the socket

* In mechanics, in the study of *simple machines* a wheel revolving round a vertical axle (as we are studying here) is called a capstan. We will, however, use the word gin, which is now accepted in practice. [Trans.]

† See *Traité de mécanique expérimentale*, p. 112.

head, which is clamped on to the drum at will. If we only have small horses at disposal, they may be yoked in pairs to each pole.

The drum A (Fig. 32), is generally made of cast iron, with flanges *n* at least 6 inches wide. These flanges are often cast together with the drum, or made of wood (Beauquesne) or steel (Bajac). It is important to prevent the cable from getting caught under the bottom flange. For this purpose a guide is fixed on an upright *e*, or the bottom flange is enveloped by a ring, the upper brim of which is level with the plane of the flange (Pelous). Accidents oftener occur when the rope is unwinding, and to avoid them the drum must be steadied by means of a brake.

To render the winding of the cable as regular as possible, it is advisable to place a runner P at a distance of about 6 feet from the axis of the capstan (Fig. 32), the height of which is level with the middle of the generatrix of the drum A. On account of the slow rate of the cable the various systems of automatic winding have been discarded. These devices were similar to those used in steam ploughing, where they are rendered necessary on account of the great speed of the cable.

To facilitate the stepping of the animals over the cable, it is advisable to have it passing as close as possible to the ground, this necessitates the use of very shallow drums, and also assists in increasing the stability.

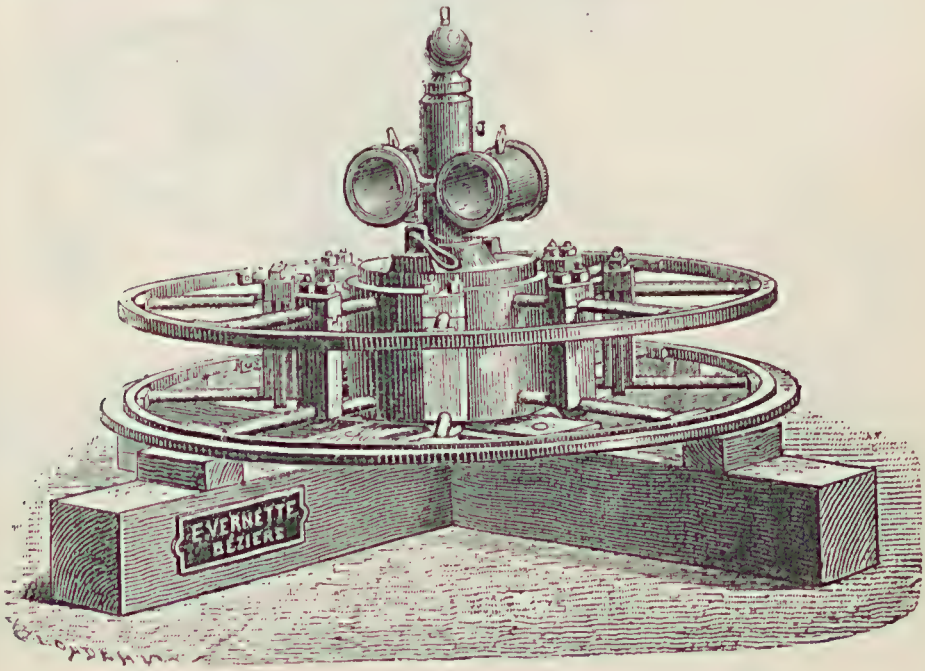


Fig. 33.—Vernette's Horse-gin, with Variable Diameter.

Generally the pole L (Fig. 32), has a constant length 11ft. 6in. to 16ft. 5in., and, according to the resistance R of the soil or the depth of ploughing, the speed, v of the plough is modified, the speed V of the motive power remaining unaltered. This is obtained by increasing or diminishing the radius r of the drum. This is often done by inserting wooden sectors, varying in width, which have also the advantage of diminishing the wear of the cable (Beauquesne). Extensible mechanisms are also in use (Vernette, 1894); the radius of the drum may by this means be varied from 12 inches to 20 inches. Finally, we may use a toothed gearing.

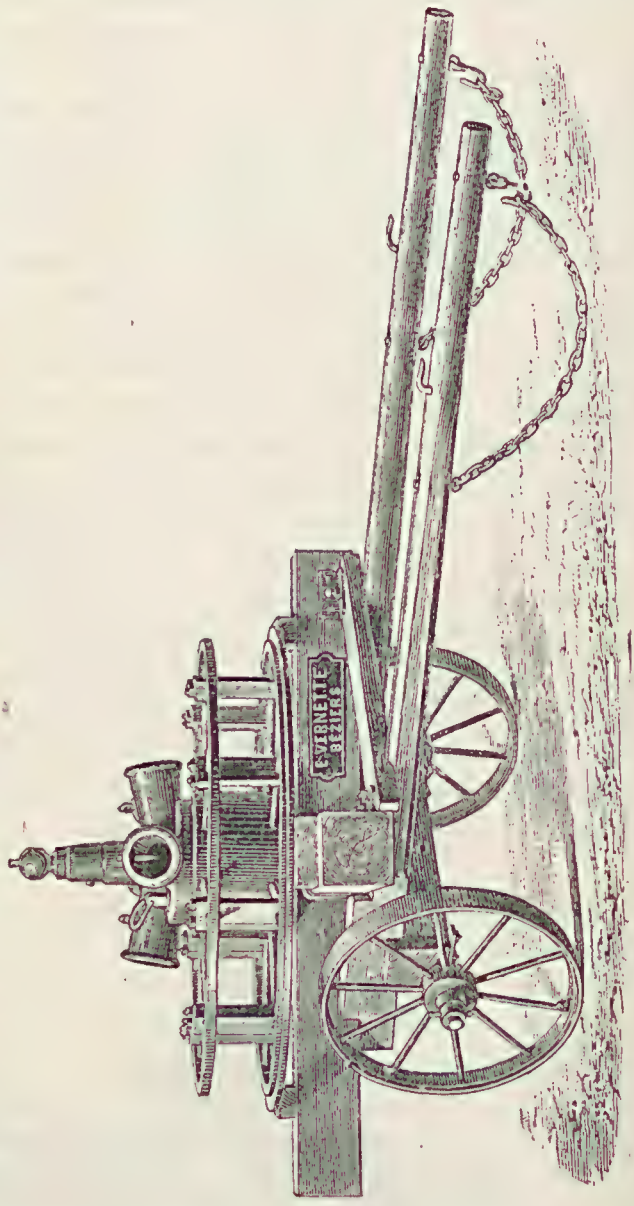


Fig. 31.—Vernette's Horse-gin, 1 test pattern.

In Vernette's gins (Figs. 33 and 34) the drum is made of two horizontal wheels, on the spokes of which cross-pieces may slide, making a skeleton drum of variable diameter limited by eight generatrices, kept in place by iron straps bolted at the top. The diameter of this drum may vary from between 20 inches to 5 feet. One revolution of the capstan corresponds, therefore, to a movement of the plough of from 5 feet to 16ft. 6in.

To enable the rate of translation of the cable to be varied, Léonce Grué modified his machine of 1876, and designed, under the name of Beaulieu-gin, a machine with cog-wheels, a diagram of which is shown in Fig. 35. (See for description, page 27.)

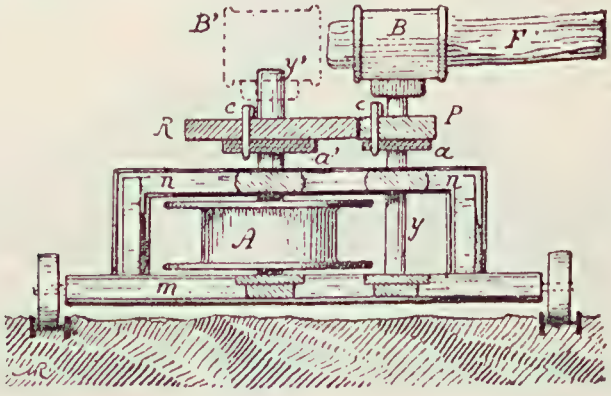


Fig. 35.—Diagram of the Beaulieu-gin, constructed by Grué.

According to models, the drum is fixed on a vertical shaft, the bottom of which revolves in a cup-socket fixed in the centre of the bed-plate, the top in a collar held in a frame or *bridge*, above which the pole-socket is fixed—Fondeur, Guyot (Fig. 16, page 37), Pelous (Fig. 36), Bourguignon, Valessie.

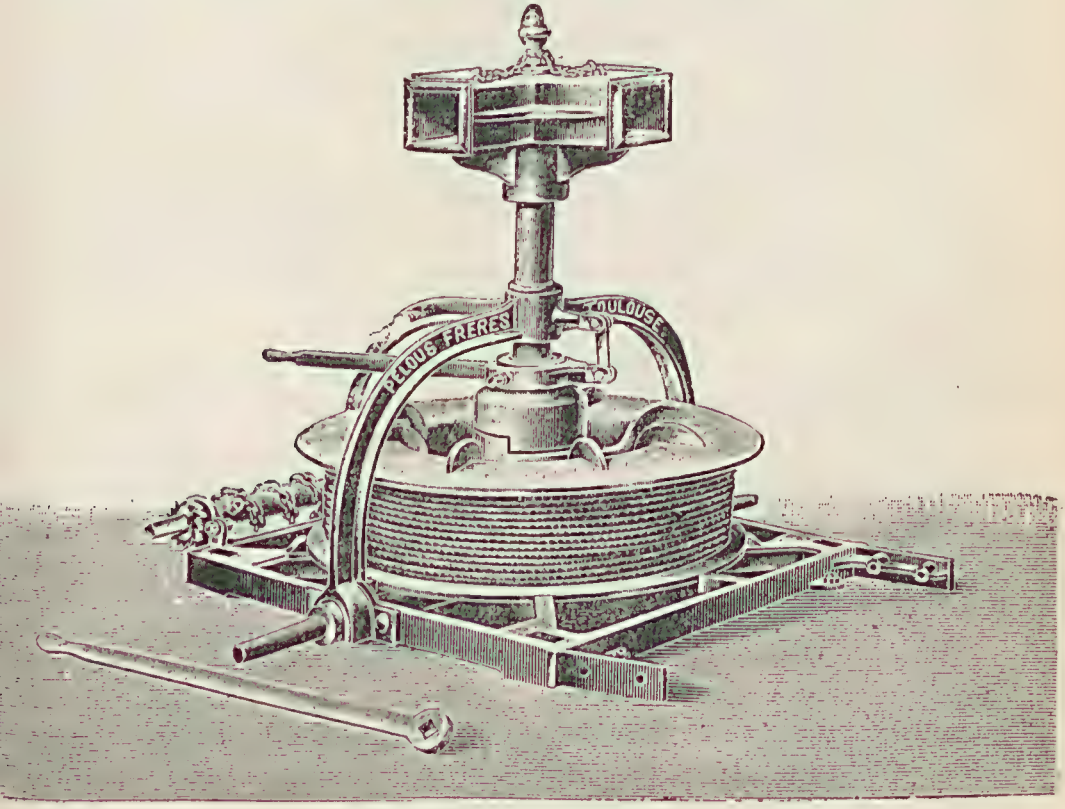


Fig. 36.—Pelous' Horse-gin.

Bajac (Fig. 37). It seems preferable to fix a pivot on the bed-plate round which the drum and socket-head revolve, Vernette (Fig. 33). Such was the system adopted by Beauquesne. During work the socket-head is clamped on the drum by a

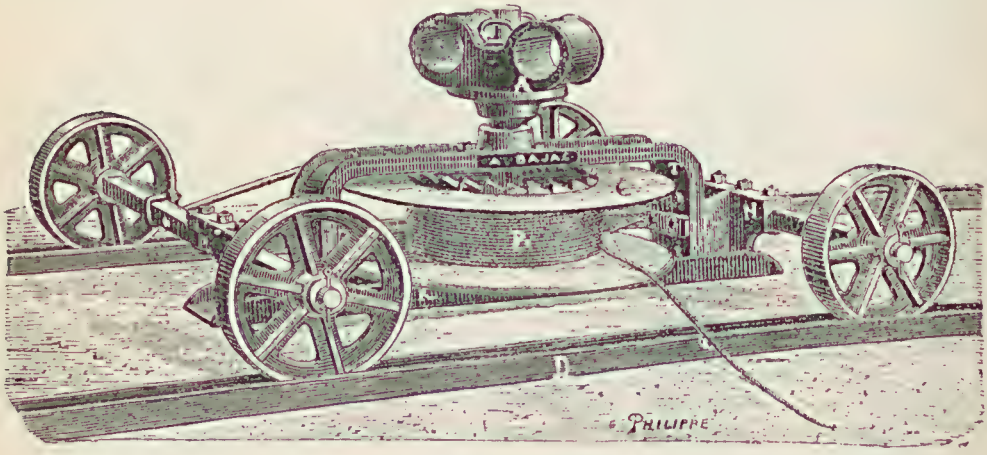


Fig. 37.—Bajac's Horse-gin.

coupling clutch, cotters or pawl, each of which may be seen in the above figures. While the plough is being taken back the drum is thrown out of gear, and the horses rested.

According to the system, the gin is either displaced before each furrow; in this case it travels on four rollers (Fig. 37), or on a bed-plate sliding on the ground, Guyot (Fig. 16, page 37) Fondeur, or it is placed in a fixed position during the whole ploughing (Figs. 33 and 35). It is kept in place by means of pegs or surcharge (Pelous). When the work is finished, the travelling of the gin is facilitated by a special frame mounted on wheels (Fig. 34), very often the bed-plate itself is provided with axles on the arms of which wheels may be fitted (Pelous, Fig. 36).

The drums are built to wind from 219 to 274 yards of cable, which is made of the best steel wire, varying from 0·5 inch to 0·6 inch in diameter.

The mechanical yield of simple-effect drums, without cog-wheels, is very high. B. Chabaneix, of the School of Agriculture, Montpellier, made trials in August, 1887, the results of which are given on page 43.

We may admit in practice that the mechanical yield of simple-effect gins varies between 80 and 85 per cent., according to the lubrication of the axles which bear enormous pressures, the length of the poles and the diameter of the drum (rigidity of the cable opposing the winding).

When the cable drags on the ground it creates a supplementary resistance. The weight of the cable is usually 8 ounces per foot, the co-efficient of friction being 0·6. Under these conditions the additional effort of traction is 0·48 ounce per foot of cable. If we assume a furrow 274 yards in length, the additional effort mentioned above at the maximum is:—

231	lbs.	when the plough is	274	yards	distant.
184·8	„	„	219	„	„
92·4	„	„	109	„	„
9·24	„	„	33	feet	„

But in practice it is not necessary to have a greater effort at the beginning of the furrow than at the end, for the cable winding round the drum increases the diameter, and therefore the leverage as the work proceeds. Finally, we have noticed the enormous traction exerted on the cable diminishes its pressure on the ground, and therefore its friction.

The ratio between the speed of the end of the pole, and the speed of the plough, varies between $\frac{6}{1}$ and $\frac{20}{1}$; the ratio usually worked at is $\frac{10}{1}$.

With the above data it is easy to calculate the effort of traction exerted on the plough.

Assuming a ratio of speed of 10 to 1.

A team of four horses, each capable of developing a traction of 220 lbs.

A mechanical yield of the machine of 85 per cent., we find :—

Mean effort of the team :

$$220 \times 4 \times 0{\cdot}77 = 677 \text{ lbs.}$$

Mean effort exerted on the plough :

$$677 \times 10 \times 0{\cdot}85 = 5{,}674 \text{ lbs.}$$

This applies only to simple-effect drums.

INSTALLATION OF TRENCHING OR SUBSOILING PLANT.

Simple-Effect Capstans.

The installation of such plant is to be considered according to whether—

1st. The capstan is displacing or not;

2nd. The hauling back of the plough takes place with a special team (one horse or two bullocks), or with an additional mechanism on the capstan;

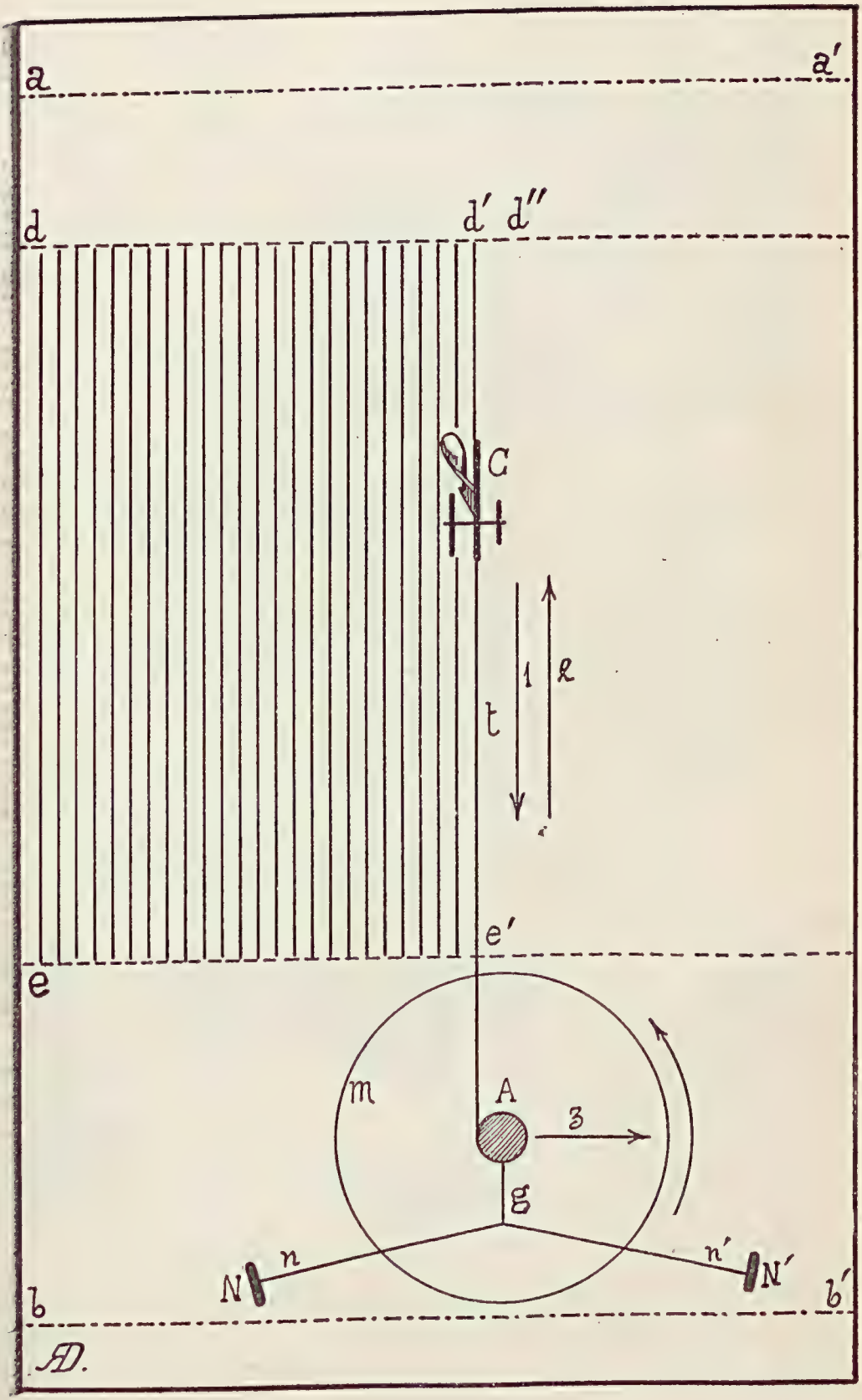
3rd. The work is done in one direction with the plough turning the sod on one side only, or in both directions with a turn-wrest or balance plough.

When the capstan is displaced for each furrow the traction is said to be direct. In this case (Plate I.), the capstan A is installed on one of the headlands *b b'*, the cable *t* hauling the plough C in the direction of arrow 1. At the start the plough is at *d'*, it opens a furrow *d' e'*, when it reaches *e'* the drum A is disconnected, the plough C taken back to *d''* in the direction of arrow 2, the cable unwinding. During this operation the horses rest and the capstan is moved a distance equal to the width of the sod in the direction of arrow 3.

With this installation, the width of the non-ploughed headland *a a'* is reduced to 9ft. 10in., while that of the headland *b b'* is equal to the diameter of the track *m* that is to say, 32 feet to 38 feet. An area *d d' e e'* smaller than the block, is ploughed that way, the two headlands *a a' b b'* being ploughed in the direction of arrow 3.

This installation, which dispenses with the fixed pulley and reduces the length of the cable (as compared with other systems) has the drawback of leaving on the capstan-side a wide headland tramped by the horses.

The displacement of the capstan A (Plate I.), in the direction of arrow 3, may be done in two different ways; the drum is fixed to a bed-plate, fastened to a chain *n g n'* secured to two anchors N N', or may travel laterally on rails.


a
a′
d
d′ d″
C
l
1
2
e′
e
m
A
3
g
n
N
n′
N′
b
b′
AD.

In the first case, a beam N (Fig. 38), 8ft. 6in. × 4ft. 3in. in section, and 3ft. 3in. at least in length, is buried in a trench 12 inches deep; behind this beam, and in a slanting direction, two pegs *p* are driven into the ground, in such a manner that the points be further apart than the heads, a gudgeon B passed through a ring of the chain *n*, rests behind the pegs, the traction of the chain being rendered even on the beam N.

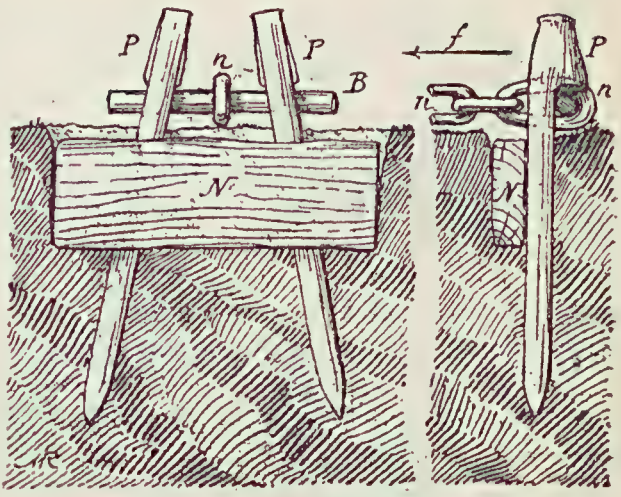


Fig. 38.—Anchoring Beam.

If we study Plate I. again, we see that when working, the capstan A exerts a traction on *g* in the direction of arrow 2, equal to the sum of the resistances of the plough C and the cable *t*. This traction is divided on the two pieces *g n* and *g n'* of the chain *n n'*, the result being a tendency to bring the anchors N and N' closer together, exerting a compressing action on the soil, which under these conditions offers great resistance.

Certain implement makers replace the beam by a wrought-iron plate, the principle remaining the same.

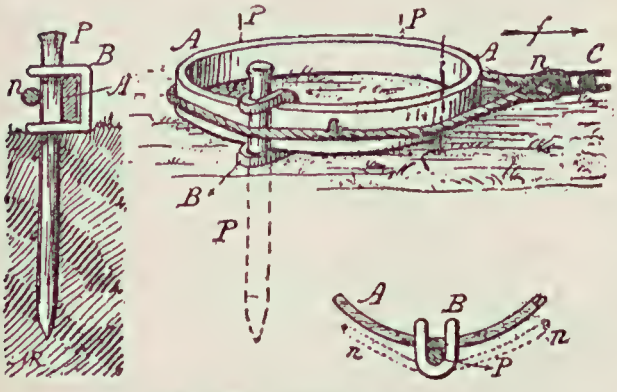


Fig. 39.—Guyot's Anchor.

Guyot now uses the anchor shown in Fig. 39, consisting of a steel ring A lying flat on the ground, and kept in place by four pegs P strapped on the ring at B, the traction chain C passes over the ring. With this arrangement the pegs blocked by the straps cannot lean, and offer great resistance to the traction *f* without requiring the ramming of the soil necessary when using a beam. (Price of anchors and

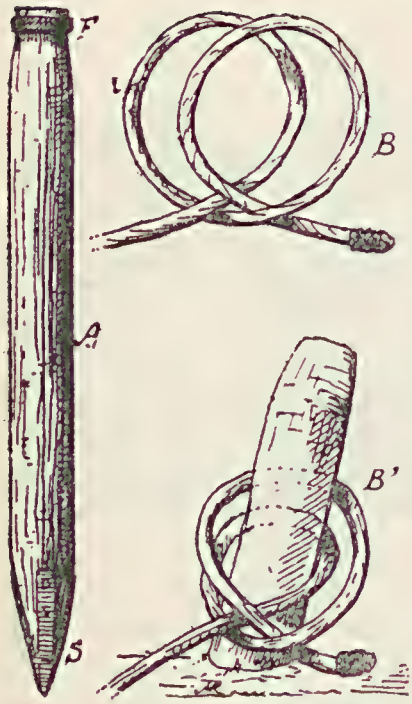


Fig. 40.—Anchoring peg and clove-hitch knot.

3in.; E, 2ft. The knot used to fasten the ropes to the pegs is the *clove-hitch* (shown in Fig. 40), or the *anchor bend*, which is still stronger

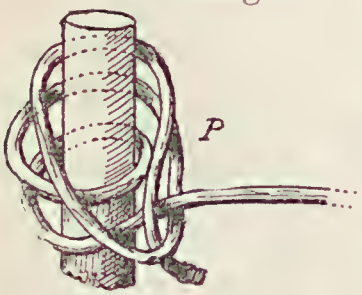


Fig. 42.—Anchor bend.

case the chain *g* is made fast to it by a gripper (Fig. 44). It is comprised of two jaws *a b* turning round a pivot *o*, fixed to a plate *m*,

chain, £5.) We may also adopt the mode of pegging used by military engineers. The pegs A (Fig. 40), are made of pine wood, they are $3\frac{1}{2}$ to $4\frac{3}{4}$ inches in diameter, terminated by a square point, provided with an iron shoe S, the other end furnished with an iron hoop F. At the foot of the peg A (Fig. 41), the anchoring cable T is fastened level with, or slightly below the surface of the soil; this peg is driven in a slanting direction to a depth of between $15\frac{1}{2}$ to $19\frac{1}{2}$ inches, its head *b* is joined to the foot of the peg B, driven 6ft. 6in. distant from it, and so forth, for the pegs, C, D, E. The length of the peg A is 5ft. 9in.; B, 5ft. 3in.; C, 4ft. 6in.; D, 3ft.

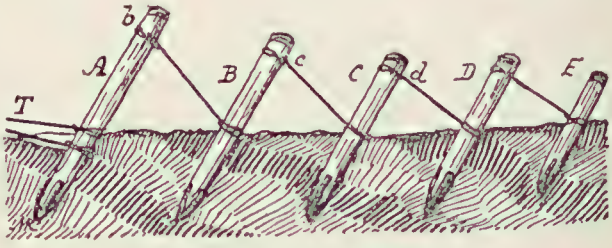


Fig. 41.—Mode of anchoring.

(Fig. 42). The cable *T* is fastened to the peg A, by two *half-hitches* (Fig. 43). The two anchors N N (Plate I.), are joined by a chain, *n n'*, 32ft. 10in. in length, to one of the links of which the chain *g* is hooked. The chain *n n'* is sometimes replaced by a steel wire cable of 0·6-inch in diameter. In this

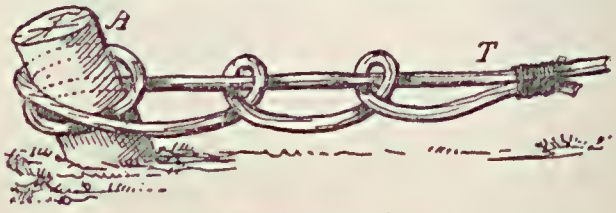


Fig. 43.—Half-hitches.

in which the cable is caught; the levers *a* and *b* are joined by the rings *c* and *d* to the chain *g*. Under the effect of the traction the cable is gripped at *m*.

Fig. 44.—Automatic Gripper.

To displace the capstan A (Plate I.), in the direction of arrow 3, the cable *g* must be slackened; this is done sometimes by hand with a crowbar, or with a special device (Fondeur and Pelous, Fig. 47), serving to haul it back. In other systems it is done by horses (Fig. 45). To displace the capstan in the direction of arrow 1 a small chain *a a'* passing over a pulley P fixed on the chain *n n'* is fastened to the pole by a hook. When the horses pull in the direction of arrow 2, the chain *g g'* is slackened; the horses are backed, the chain *a* unhooked from the pole L, and the point of traction *g* shifted a distance equal to the width of the sod to be turned.

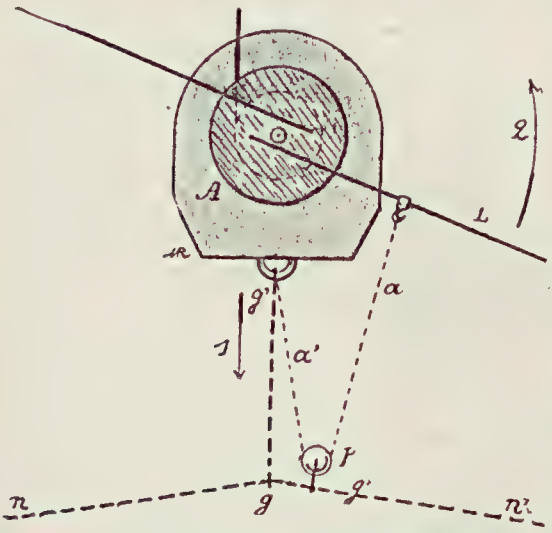


Fig. 45.—Diagram showing how the Capstan is Displaced.

To facilitate these different operations, several implement makers mount the capstan on four rollers travelling on rails.* The rails are made of iron rolled joist girders, as used in structures (T Fig. 46), lying flat on the previously levelled ground.

The traction R exerted on the rollers resting against one of the flanges is equilibrated by the resistance of this beam gripping in the ground; this is why it is preferable to sink the beam in the

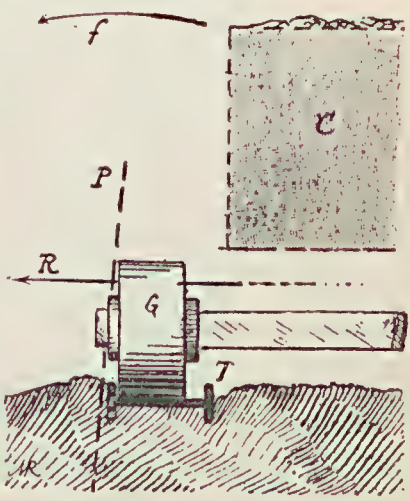


Fig. 46.—Diagram showing the Position of Rollers on Girder.

* In 1889 H. Beauquesne (*Journal d'Agriculture Pratique*, Vol. I., p. 460), mentioned this device as having been applied before by Grué, Valessie, and several others.

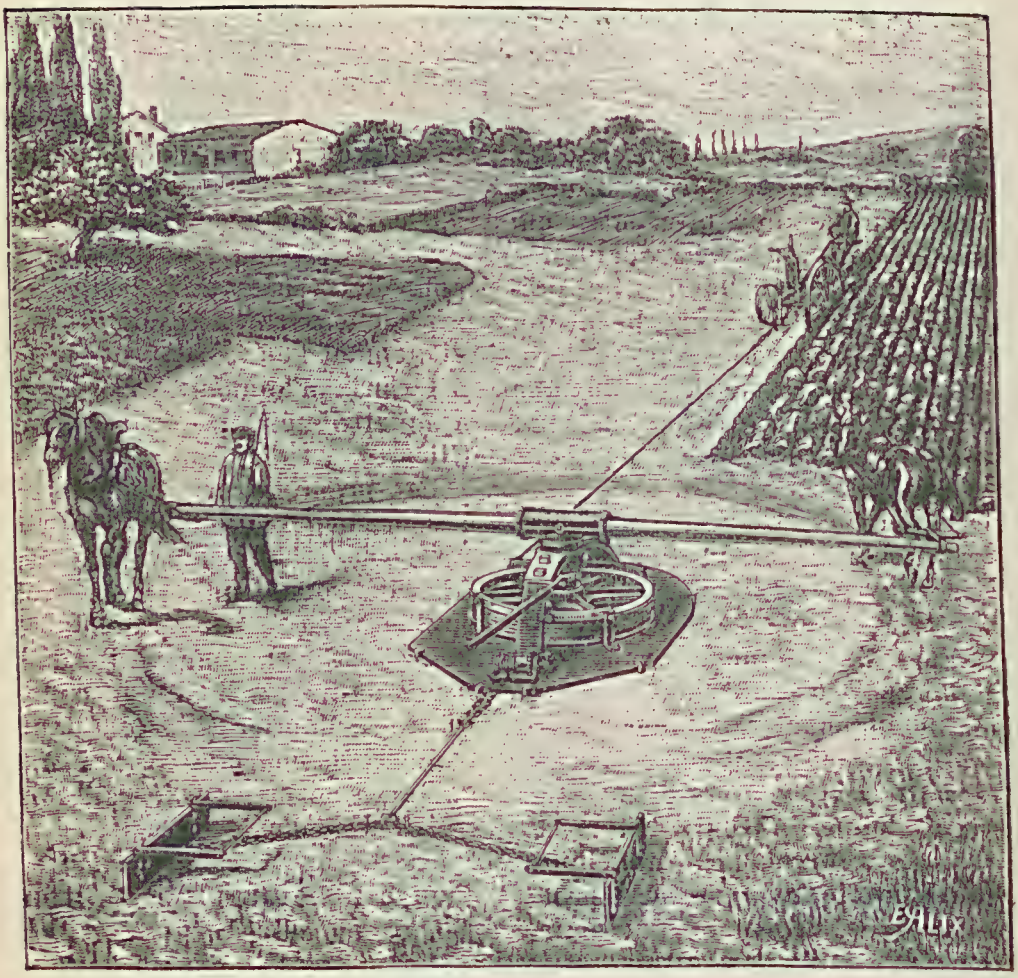


Fig. 47.—Fondeur's Plant.

ground throughout its length. This operation is easy when the ground is slightly damp, for the penetration takes place of itself. If not, it is necessary to drive pegs P in a slanting direction, or to increase the weight of the system by cases C filled with earth. Finally, to prevent the rollers from becoming derailed, the cable must be kept as close as possible to the ground. If not the machine has a tendency to tilt over in the direction of the arrow *f*.

With such an installation four girders only are necessary, alternately displacing each pair.

With the object of dispensing with the horse and boy required for hauling the plough back, implement makers construct capstans provided with an additional mechanism which does the work. This device is undoubtedly handy when steam is used, but complicates the horse-gin unnecessarily. The cable used is 0·35 to 0·39 inch in diameter.

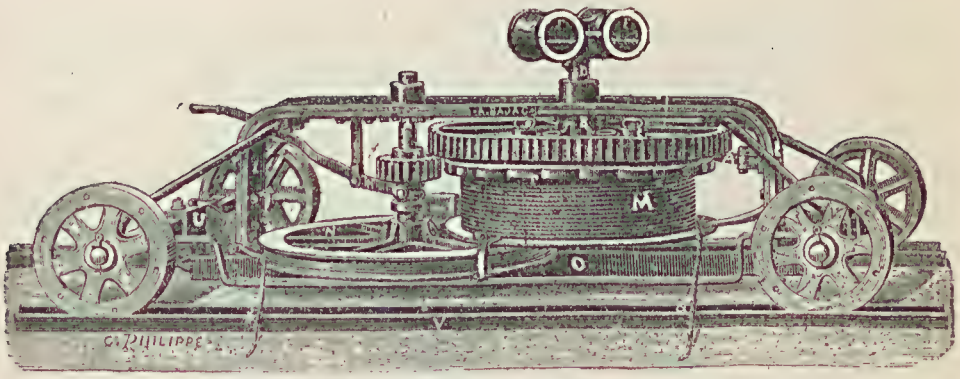


Fig. 48.– Bajac's compound Horse-gin.

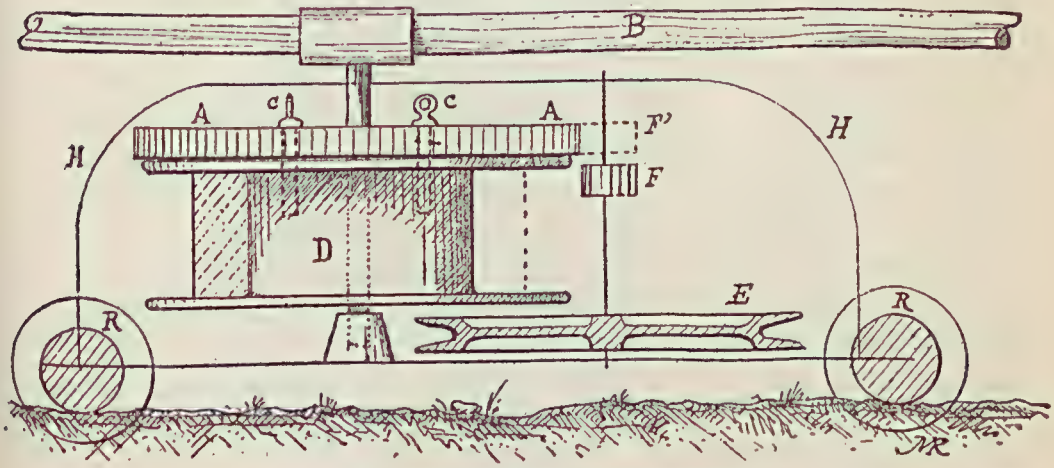


Fig. 49.—Diagrammatic section of same.

In Bajac's gin (Agricultural Show of 1892), shown in Figs. 48 and 49, and Plate II., the large cog-wheel A connected with the pole B, can be clamped to the drum D by means of two pins *c*. The hauling-back cable winds on the groove of the pulley E connected with the pinion F, which engages the cog-wheel A, when the drum is thrown out of gear; the pinion F is worked by a lever shown in Fig. 48, in which may also be noticed the pawl clicking with a ratchet on the top flange during the work. When the plough reaches the end of a furrow the drum *d* is released, the pulley E thrown into gear, the hauling back cable passing over the fixed pulley and winding round it, pulls the plough back to the start; the horses always turn in the same direction. According to the stiffness of the soil, the diameter of the drum may be increased by wooden sectors, as shown in Fig. 49.

The whole mechanism is carried in a strong frame, travelling on four discs with a sharp edge, penetrating the soil, as shown in Fig. 49, or by rollers on rails (Fig. 48).

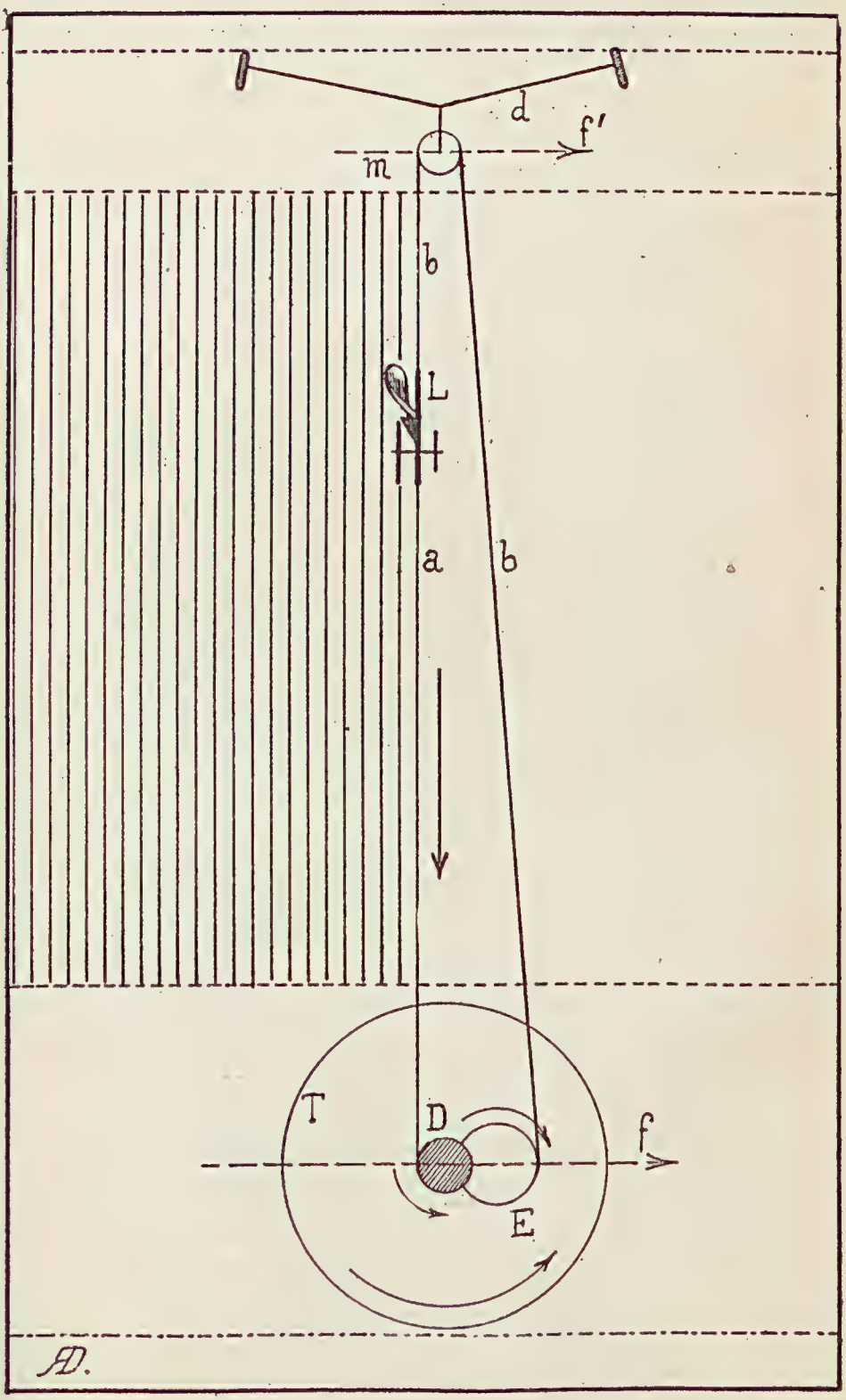
Plate II. shows the installation of the plant in the block; the traction cable *a* fastened to the plough L, winds round the drum D; the hauling-back cable *b* passes over the fixed pulley *m* and winds round the drum E. After each furrow has been turned, the system is displaced in the direction of the arrow *f*, by an additional small capstan, or on rails. The pulley *m* is displaced in the direction of the arrow *f'*, for a distance equal to the width of the sod. The pulley *m* is fixed by a chain *d* stretched between two anchors.

With the object of ploughing both ways with a balance-plough, it has been proposed to install two gins, one on each headland (Plate III.). The horses work alternately, as shown in Fig. 50, but the part unploughed measures 32 to 39 feet on each side. This arrangement, which requires two machines, is convenient when one cannot spare much time for the operation. Under favorable conditions, it is possible to plough ½ acre per day with such an installation.

It does not, however, do more work per horse per day. Let us consider the following figures resulting from personal observations in the field: A gin with two horses hauls a plough at a rate of 2 inches per second, turning a sod 21½ inches wide and 15½ inches deep; the hauling back is done by a horse travelling at a mean rate of 19½ inches per second. Assuming a length of furrow of 219 yards we arrive at the following conclusions:—

	System with— 1 Capstan.	2 Capstans.
Number of horses yoked to the capstan...	2	4
" " for hauling back ...	1	0
Total	3	4
Time required to open one furrow:		
Working forward	67 seconds	67 seconds
Throwing the plough out, disconnecting the drum	2 "	0 "
Hauling back	7 "	0 "
Starting the plough...	3 "	0 "
Balancing and starting the plough ...	0 "	5 "
Total per furrow	79 "	72 "
Actual work done per hour:		
Length of furrow	166 feet	180 feet
Surface ploughed (in square yards) ...	99 yds.	108 yds.
Surface ploughed per horse and per hour (in square yards)	32 "	27½ "

The difference is quite as marked if four horses are used and the speed of the plough greater.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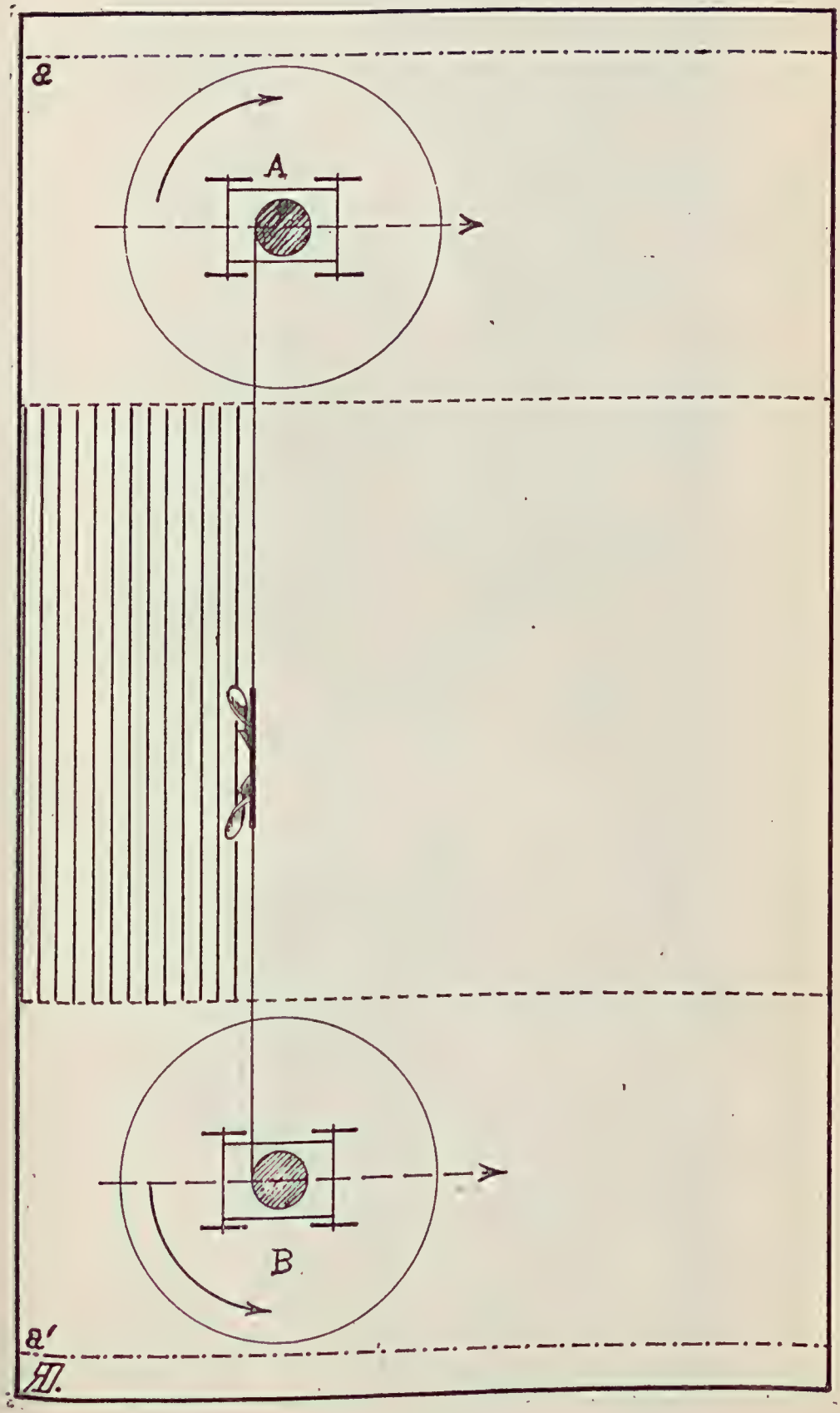
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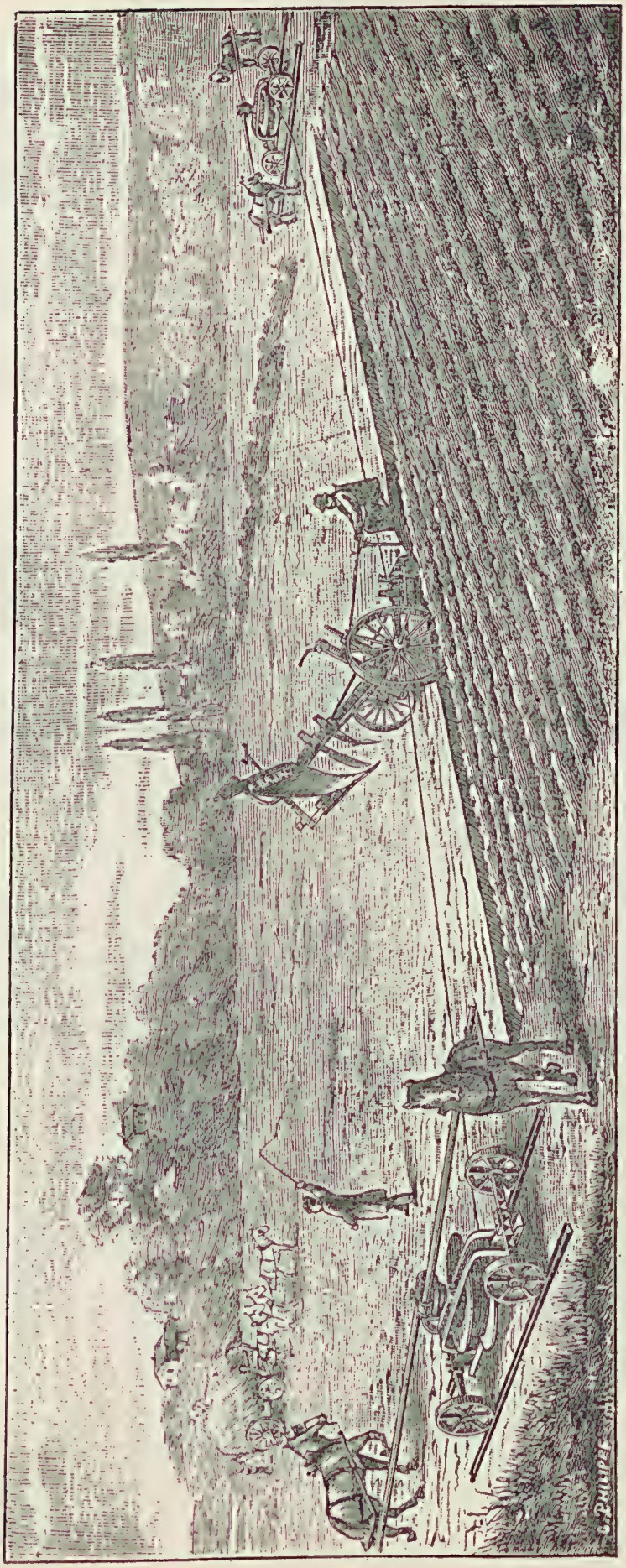


Fig. 50.—The Double-gin System.

Double-effect Capstans.

Finally, with the object of doing more work with one capstan, balance-ploughs, ploughing both ways, have been tried. In this class we may mention Debains' system, exhibited by Tritschler at the general annual show held at Paris, 1892.

Diagram 51 and Plate IV. show the capstan A, with two bevel-pinions B and C, gearing together, and on the horizontal shaft a coupling-clutch *d* allowing the drums E and F to be

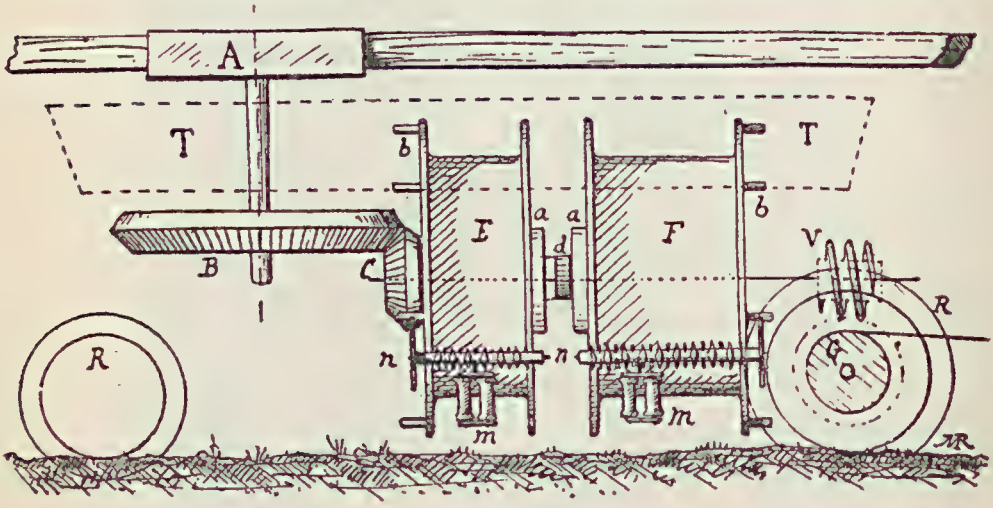
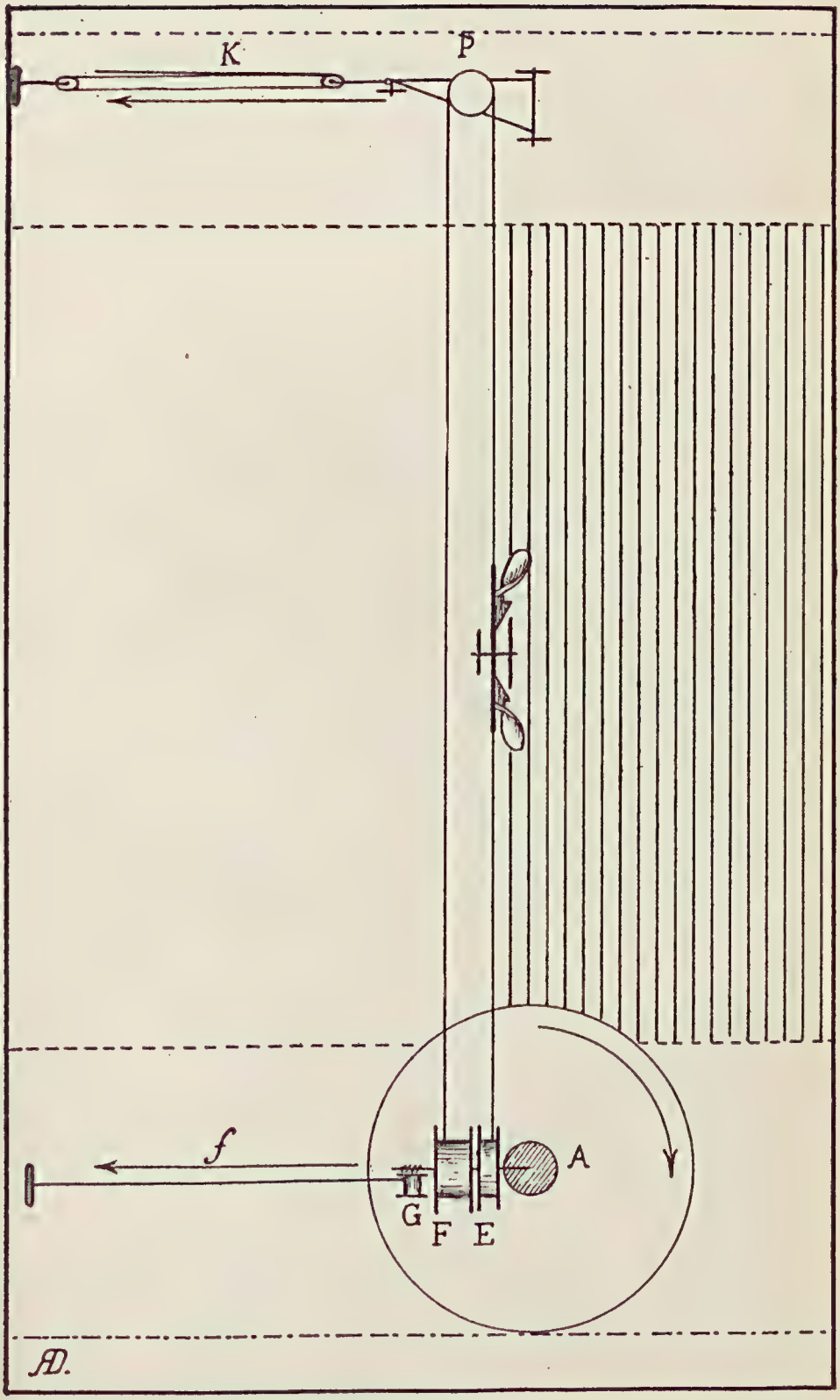


Fig. 51.—Diagram of Debains' compound system.

engaged alternately. The two drums are equal in diameter, but of different width. On the drum E, a direct traction cable winds which is fastened to the balance-plough. On the drum F, which is double the width of E, the hauling-back cable double the length is wound. Brakes act on the flanges *a a* to steady the unwinding; two winding guides *n n* revolve on a horizontal axis, on which two spirals are fixed, wound in opposite directions, forcing the guides *m m* to travel right and left alternately; each spiral is worked periodically by the pins *b* fixed on the flanges of each drum.

Debains' machine is mounted on four iron discs penetrating the soil and acting as anchors. The front axle is fixed by a king-bolt, enabling the machine to be turned; a small capstan G gearing with an endless screw B serves for the lateral displacement. A case T may be loaded with earth.

Plate IV. shows the projection plan of the system at work. The capstan A, the drum F, the plough M, the fixed pulley P, and its automatic anchor, provided with


K
P
f
A
G
F
E
AD.

three wheels, displaced by the block and tackle K, are shown in position. The additional capstan G is anchored to a fixed point by the chain *f*.

Machines such as that above described, with complicated mechanism and smaller mechanical yield than simple-effect capstans, require frequent stoppages in course of work in order to rest the animals. In conclusion, the use of balance-ploughs is of no practical benefit when horses are used.

Stationary Winding Drums.

When the capstan has to be displaced before every furrow, time is wasted, not only in ploughing the wide headland on which the machine is displaced, but the horses become also very tired through not travelling on a beaten track, having to walk on new ground after every displacement. The whole machine has also to be moved while the plough is hauled back. In 1888 the advantage of using a longer cable, a fixed pulley and a stationary capstan was recognised. The capstan may be stationed in the centre of the block if it is large enough (25 to 37½ acres), or in a corner of the block if smaller. With this arrangement a certain amount of mechanical power is lost* but this loss is relatively small, and is compensated by the facility of the execution of the work, and by the diminution of the width of one of the headlands, but we will see that the anchoring of the fixed pulley requires to be done with the greatest care, and, very often, it cannot be anchored at all in loose, soft ground.

The installation of the complete plant in working order is shown in Plate V. In one of the corners of the block, *a a'*, *b b'* (or outside if possible), the capstan A is strongly bedded. The traction cable *t* fixed to the plough C passes over the fixed pulley P anchored in *n n'*, hauling the plough in the direction of arrow 1, and is hauled back in position in the direction of arrow 2. With such an arrangement,

* To give an idea of the mechanical power lost, we quote the following figures :—A traction cable 109 yards long, sliding on the ground with a speed of 3·94 inches per second, requires 4 to 5 kilogrammetres per second. A fixed pulley 31½ inches in diameter, mounted on an axle 2·3 inches in diameter, over which a cable passes exerting a traction of 3 tons (resistance of a very powerful trenching plough) requires 67 to 68 kilogrammetres per revolution. The addition of a fixed pulley absorbs an average of 8 to 10 per cent. of the traction power of the cable.

the width of the headlands *f f'* may be reduced to a minimum. When the pulley P is very far away from the capstan A, it is advisable to use fixed runners *x;* these will be studied later on. Plate VI. shows diagrammatically the arrangement for trenching or subsoiling a large block *a b c d*; the capstan A is stationed in the centre of the block, which is divided into four sections, *e a f* A, A *f b g*, A *g c h*, *e* A *h d*, ploughed in the direction of the arrows using a fixed pulley *u*. The headlands are also ploughed without moving the capstan, in the direction shown by arrows *n*, by fixing the pulley in *e* and *g* on the lines *a d*, *b c*. With 328 yards of cable, 20 to 22½ acres may be ploughed with this arrangement without moving the capstan.

Sometimes the capstan A (Fig. 52), is placed in the gravitation centre of the surface to be ploughed, and, without using any fixed pulley, the plough C works in the direction of the radii, as shown by the dotted lines ; but this arrangement, which does away with the fixed pulley and the waste of power incidental to it, necessitates the ploughing of convergent furrows, which are difficult of execution, and, if the workmen are not closely supervised, they leave portions of the ground unploughed. We visited a block ploughed by this system ; 7 per cent. of it had not been touched by the plough.

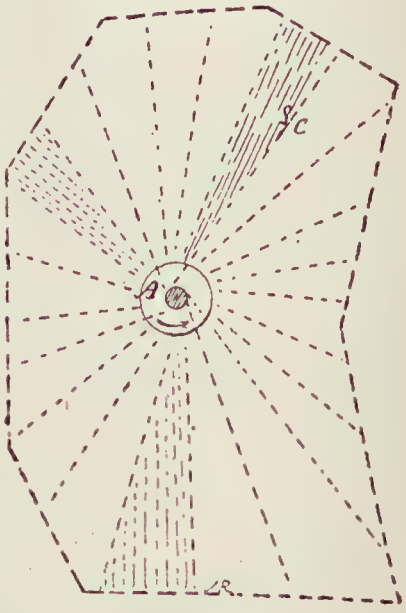
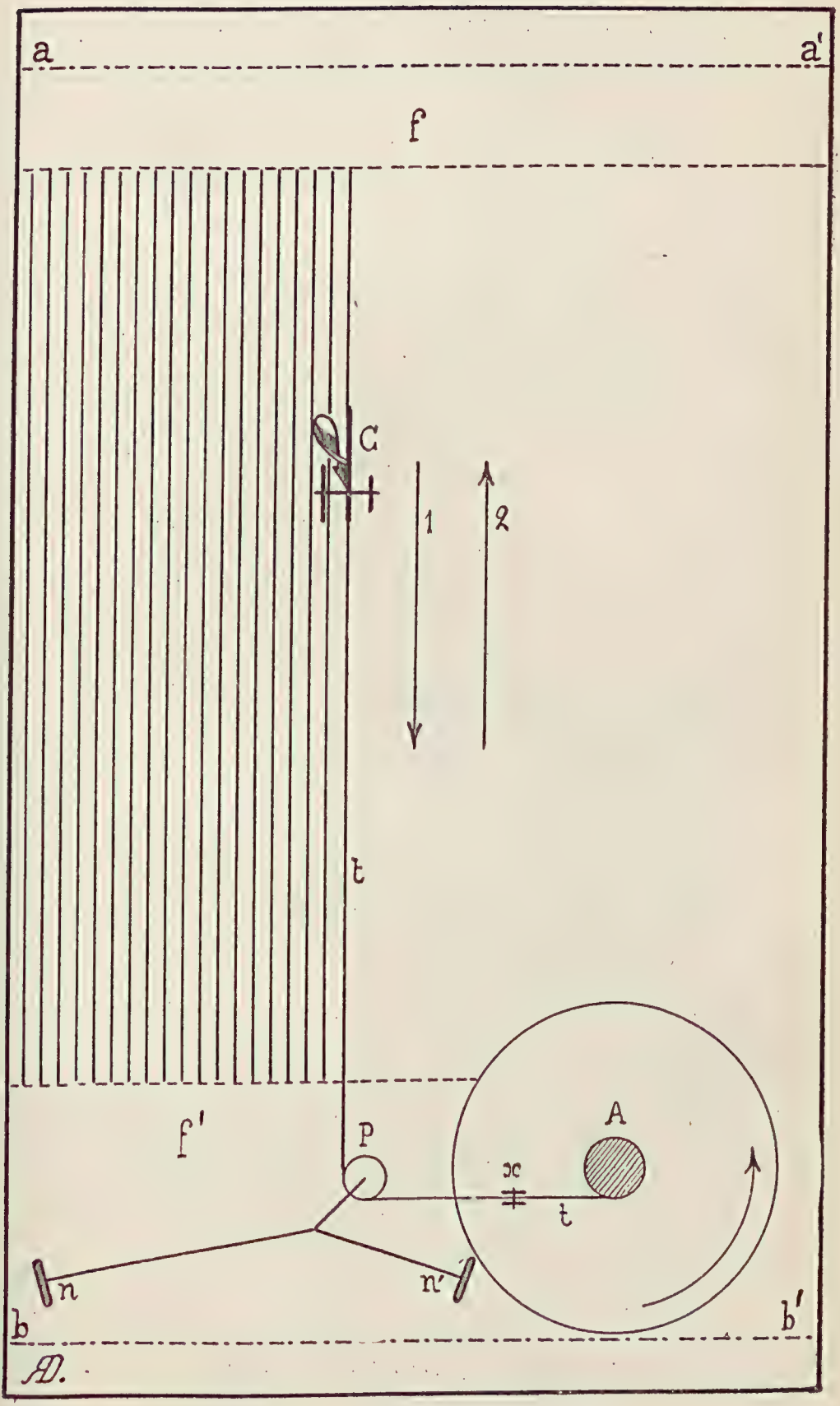


Fig. 52.

The installation of stationary capstans allows the use of a second cable, as shown in Plate VII. The drum A hauls the plough C, in the direction of arrow 1 by the cable *t* passing over the pulley P. The drum B revolving in an opposite direction, hauls the plough back by the cable *r* passing over the pulley *u*, in the direction of arrow 2. It is advisable to support the cable *r* on runners *m* moving sideways automatically with the cable.

Stationary capstans are built so as to be worked either by horses or steam power ; Pelous' drum (shown in Fig. 53) is an example of this principle.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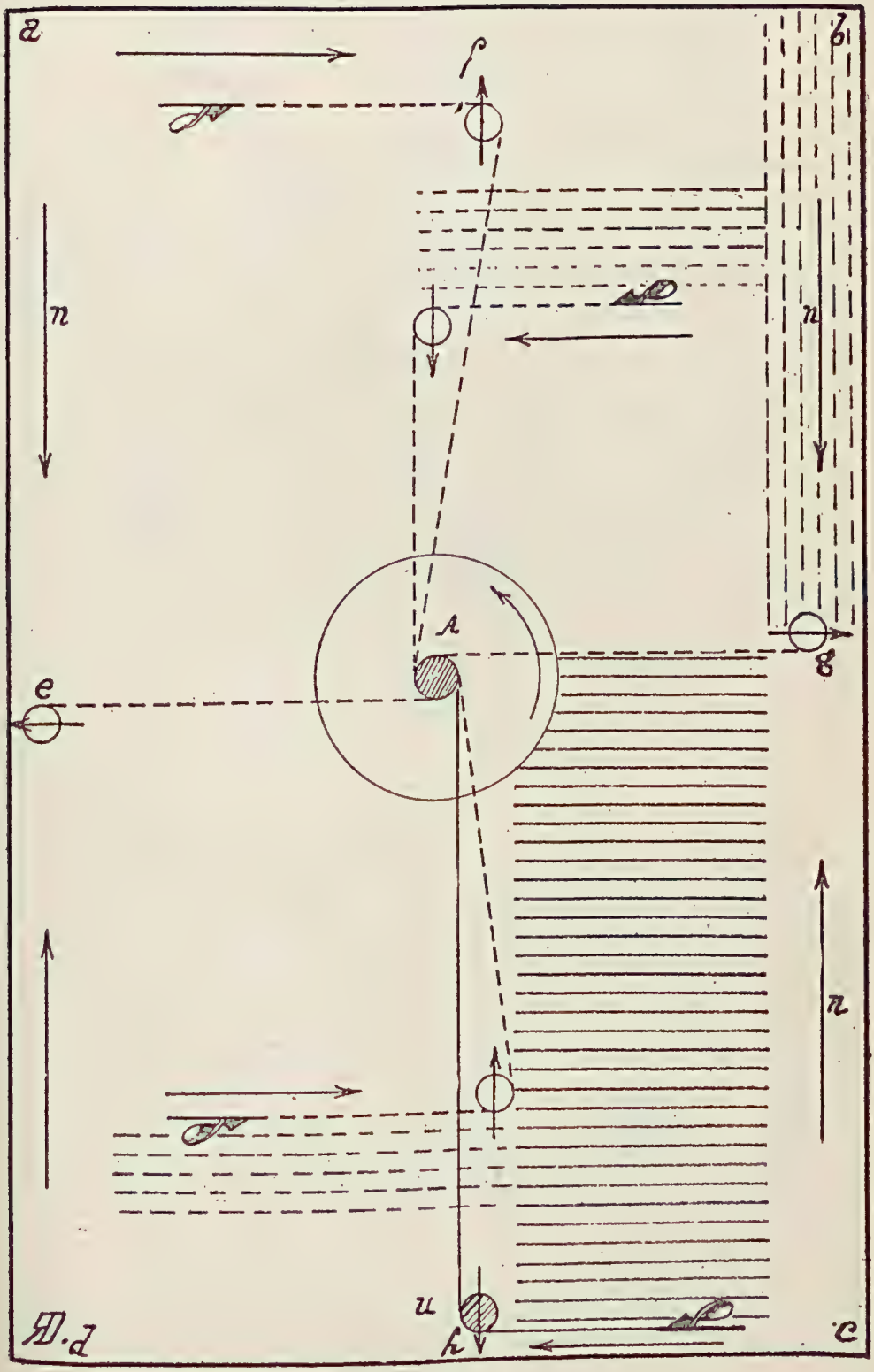
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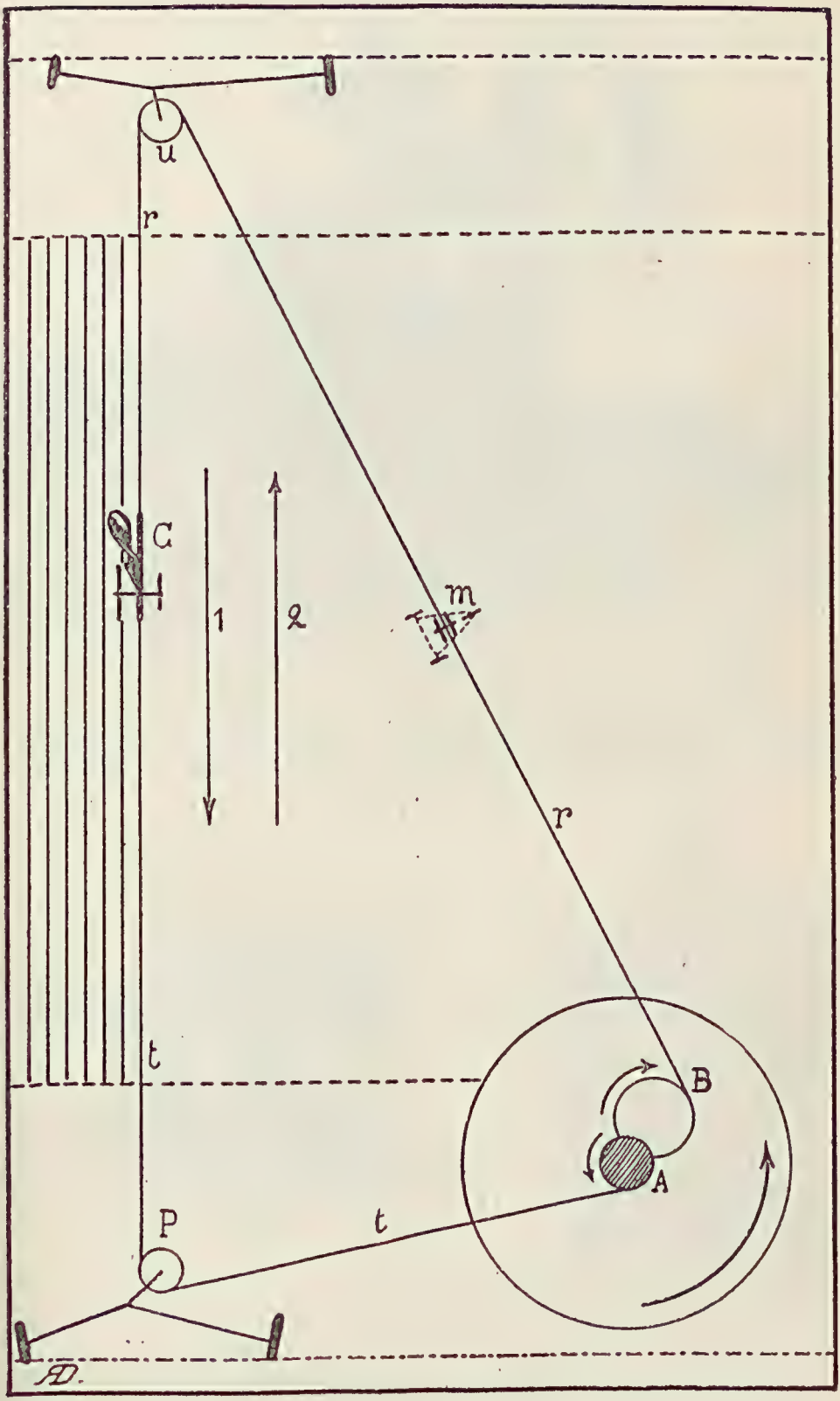
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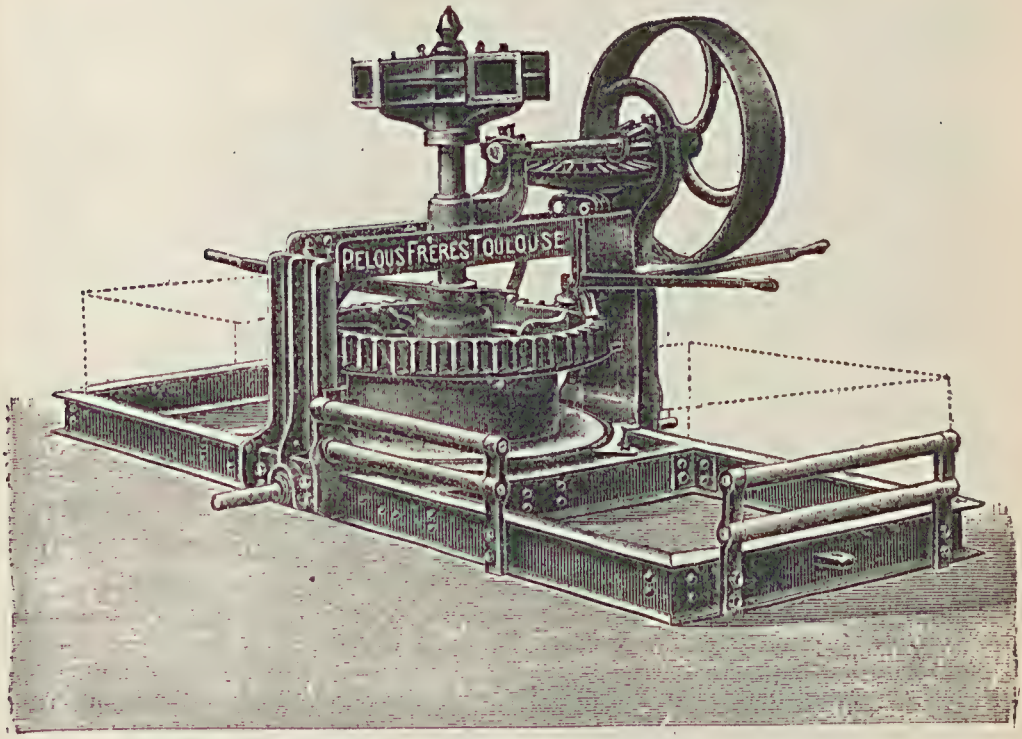

Fig. 53.—Pelous' Combined Capstan working by horse or steam power.

The fixed pulleys P (Fig. 54) are made of cast iron of a diameter varying between 23½ and 31½ inches, revolving around a steel pivot fixed in a block *a* secured to the anchor

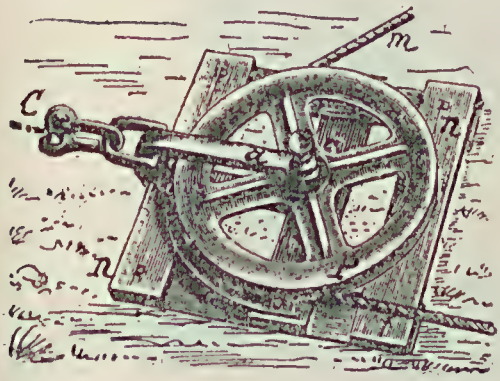

Fig. 54.—Fixed Pulley.

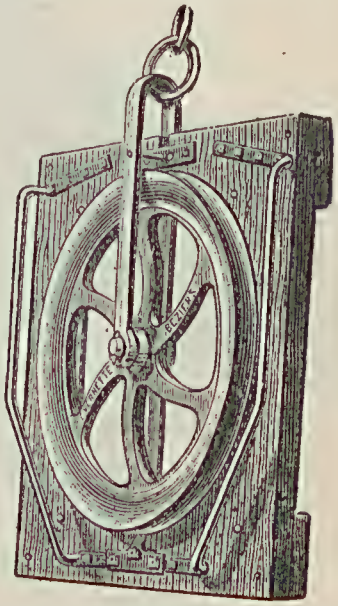

Fig. 55.—Pulley with cable-guard.

by means of a chain C. The whole arrangement is mounted on a wooden or iron square plate *n* of from 27½ to 35½ inches wide, on which is often fixed a triangular arrangement

called a cable-guard (Fig. 55), to prevent the cable from leaving the groove or getting jammed between the block and the sheave.

The block of the pulley P (Fig. 56) is fastened by a small chain *n* to the link of a large chain *a b c*, the extremities of which are secured to the anchors A A′; at each furrow the point of traction *n* is displaced in the direction of *b* a distance equal to the width of the furrow. If the traction cable C C′ is returned at a right angle on the pulley P, the effort *f* gives with effort *f′* * the resultant effort R which being reported on the point of traction *n*, may be resolved into its two components *p* and P, which represent the effort of traction exerted on the anchors A′ and A. This diagram shows that the anchor A has to support an effort much greater than the anchor A′ and also much greater than the effort *f* of the cable.

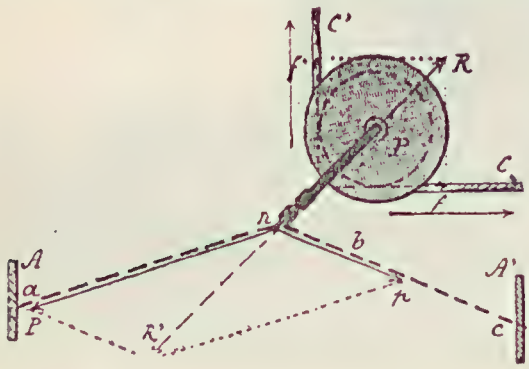

Fig. 56.—Diagram showing resultant of efforts of traction.

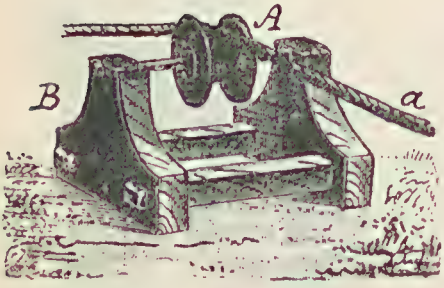

Fig. 57.—Stationary Runner.

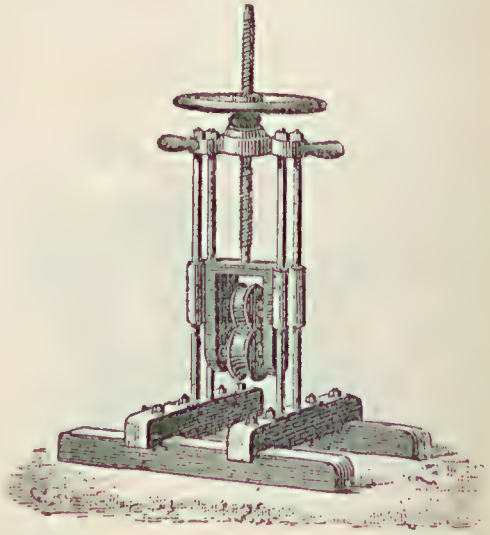

Fig. 58.—Stationary Runner used near the Capstan.

* The effort *f* is equal to effort *f′* (resistance of the plough and friction of the cable on ground), plus the friction resistance of the pulley and the resistance of the cable to bending round the pulley. Therefore, in reality, the effort *f* is a little greater than the effort *f′* and the resultant R is the diagonal of a rectangle.

For this reason great attention must be paid to the fixing of this anchor, as otherwise it would be pulled out during the course of work, involving undesirable waste of time. The chain *a b c* (Fig. 56) is about 65 feet long. After a certain number of furrows have been ploughed, this anchoring chain is displaced along the headland towards the capstan. The anchor A being fixed 65 feet to the right of the anchor A′.

Generally the cable is allowed to slide on the ground; however, when stationary capstans are used it is preferable to support the cable on runners. Figs. 57 and 58 represent stationary runners, the cable *a* passing in the groove of a pulley A revolving on a horizontal axle mounted on a wooden frame.

When hauling back cables are used it is advisable to support the small cable on runners travelling sideways automatically with the cable (Fig. 59). This figure shows one of these ; the pulley A is mounted on a wooden framework B travelling on three wheels R, revolving in a direction perpendicular to that of the cable. Movable runners are also made with iron frames (Fig. 60).

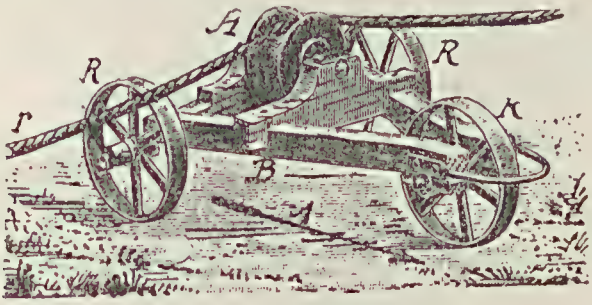

Fig. 59.—Movable Runner.

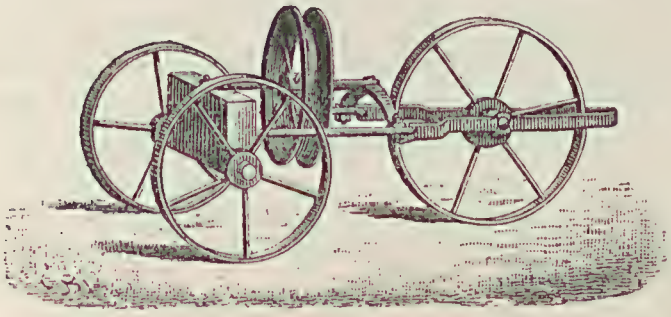

Fig. 60.—Movable Runner with iron frame.

Work of Horse Winding Drums.

The quantity of practical work done by a horse winding drum depends on the following conditions :—

Power of the team.
Resistance of the plough. (Nature of soil and dimensions of block.)
State of material.
Dimensions of block, and arrangement of plant.

The power of the team and the resistance offered by the soil are in relation to the section of the sod and the speed of the plough. That speed, together with the width of the sod and unavoidable losses of time, determine the amount of work done per hour.

The state of material bears by its mechanical yield on the traction power available on the plough.

The dimensions of the block, and arrangement of the plant, more or less favorable to the work, influence the time lost in proceeding from one furrow to another ; for instance, the longer the furrow the less the loss of time. However, other considerations may modify the arrangement of the plant, for instance, in very stiff soil it is advisable to run the furrows in such directions as to follow the fall of the ground to assist drainage of the water in the subsoil.

For light soils the season of ploughing has not a very great influence on the results of the operation. In clayey soils it is advisable not to plough when they are too wet, as the mould-board always exerts a certain compression on the sod, which makes it cling together like a brick, and forms large compact clods, often remaining in that state for many years.

The staff necessary for working the plant is generally increased by a few men, who remove large stones, roots, and bushes, which it is detrimental to leave in the ground.

The following is an example of the method of calculating the practical work of a trenching or subsoiling plant :—

	Yards.	Yards.	Yards.
Length of furrow ...	219	219	219
Speed of plough (inches per second)	2	2·75	3·94

Time required in Minutes:

To turn 1 furrow ...	67	48	34
Lost in various operations (lifting plough at end of furrow, 2 minutes; return 8 minutes; placing at start of furrow 5 minutes), total	15	15	15
Total required to open 1 furrow 219 yards in length	82	63	49

Practical Work per hour:

Length of furrow, in yards	158	207	262
Area ploughed in square yards, the width of the furrow being 25½ inches ...	112·8	149·4	187·2

The practical results shown by this last line would be modified if other lengths of furrows were considered, the time spent in lifting the plough out of the furrow and placing it in position at the starting point being independent of the length of furrow considered.

The depth of ploughing is generally fixed beforehand, and the width follows The section of the sod and the resistance of the soil per square inch give the mean hauling power required on the cable, from this the number of horses required to work the winding drum may be deduced, and from their energy the speed of the plough.*

We have already given several examples of the method of calculating the different elements of work for winding drums (traction of ploughs, power of teams, mechanical yields) we must now give some practical indications resulting

* If we designate by n the number of animals yoked to the drum ; t the mean power (in kilogrammetres, 7·233 foot-pounds, per second) which each horse may furnish (see page 65) ; m coefficient of reduction variable with the number of animals in the team (see page 66) ; k the mechanical yield of drum and cable varying between 0·8 and 0·9 ; p the depth of the furrow, varying between 14 inches and 27½ inches ; l the width of the furrow, equals $1·3 \times p$, varying between 15 inches and 35 inches; e the mean traction per square inch of section of sod, varying between 330 lbs. and 660 lbs.; v the speed of the plough per second in decimal fractions of a yard. The equilibrium of the system is given by the following formulæ :—

$$n\,t\,m\,K = p\,l\,e\,v,$$

or by

$$n\,t\,m\,K = 1·3\,p^2\,e\,v.$$

from ordinary field work. Dufaure has favoured us with details of his practical field work, from which we extract the following:—

With the object of planting a vineyard, Dufaure trenched land during 1889–90 to a depth of 16 inches, the nature of the subsoil not allowing it to be trenched deeper ; he used Beauquesne's plant, consisting of a fixed winding drum, a steel wire cable 274 yards in length, and a pulley hooked to the link of a chain anchored on the opposite headland by two anchors.

The winding drum worked by four horses could haul a very strong plough, but as the soil would not allow trenching to a very great depth, Dufaure, in order to make full use of the plant, fastened two ploughs to the cable, working to a depth of 15½ to 17½ inches, with a width of furrow of 19½ inches The extremity of the cable was made fast to a very strong swingle-bar 20 inches in length, one extremity of which was fastened direct on the whipple-tree of one of the ploughs, and to the other plough by a chain 10 feet in length.

When the two furrows were completed, the two ploughs were placed on their sledges and hauled back, this took from five to seven minutes, and was also indispensable to rest the horses working the drum.

The staff was—

3 men: 1 at the capstan, 2 accompanying the ploughs.

1 boy.

4 horses (in preference old buggy horses with long and steady stride).

2 bullocks, used to harrow behind the two ploughs, and to haul them back.

In a soil of medium stiffness the work per day of eight hours actual work, was 100 poles. It is to be noticed that except in the case of very bad weather, neither rain nor snow interrupted the work, as the horses had a hard tramped track to walk on.

The shifting of the winding drum was laborious, and required four skilful men working the whole day, to shift it from one block to another. It is advisable to reduce these shiftings by a little care in the choice of the different spots.

In a block of 17¼ acres the trenching took twenty days of actual work without shifting the drum, and, if Sundays and stoppages are taken into consideration, from the 23rd December to the 11th February. It was noticed that during this work the horses travelled at the speed most convenient to them, and without those jerks occurring so continuously when the horses are yoked direct to the trenching plough.

The cost of the whole material (drum, cable, pulley, ploughs) was £100.

The daily expenses were—

	s.	*d.*
4 horses at 4s.	16	0
2 bullocks at 1s. 7d.	3	2
3 men (per day 1s. 7d.; premium on work 4½d.)	5	11
1 boy	0	6
Writing off interest and keeping material in repair ...	3	0
Total	28	7

The cost of trenching 1 acre in 1⅛ day would be therefore £2 10s. This cost is a minimum, and it is better to allow between £3 8s. and £4 4s. for depths varying beween 15½ to 17 inches.

This is about the cost of the same work done by Verneuil, a neighbour of Dufaure's, who, not being able to utilize the winding drum on account of numerous banks of rock rendering the work too irregular, yoked five pairs of bullocks direct to a plough, similar to that used by Dufaure. But it must be noticed that during the month of January, which was very wet, Verneuil had to stop the work completely and feed bullocks which were not utilized, while Dufaure only lost five or six days in the same month.

Dufaure was able to plough a block 490 yards in length by lengthening the cable supported by a few runners; this great length of cable did not appear to increase the resistance much. The work of levelling was simplified by a wooden beam 4ft. 10in. in length, 6 inches in diameter, fastened at the rear and dragging on the soil, the soil being left much better levelled than when harrows were used.

Dufaure performed his ploughing from the 15th November to the end of February, and always noticed that horses which were very poor at the end of the summer, used to rest and fatten during the work of the winding drum, which works regularly without jerks on account of the elasticity of the cable, acting as a buffer.

De Juge* used for trenching his land, a winding drum hauling the plough direct and displaced at each furrow. From the 8th to the 20th December he ploughed 360 poles, of a soil formed of an agglomeration of clay and pebbles, to a depth of 24 inches. Taking into account the cost of bullocks and manual labour (which is very cheap in that district) the cost per acre reached £8.

At Fondouck (Algeria, 1898) a plant, comprising a Vernette winding drum stationed in the centre of the block, was worked by five mules, a man, and boy; the plough was worked by a man and boy, a team of two bullocks, and a horse and a driver to haul the plough back, that is to say (without counting the men digging out stones and large roots, staff paid for by the proprietor), altogether :—

3 men,
2 boys,
5 mules,
2 bullocks,
1 horse.

The depth ploughed was 14 inches, and $2\frac{1}{2}$ acres were ploughed in seven days. The contractor did the work for the sum of £4 10s. per acre, the proprietor having to board men and animals. The plough turned a sod of 20 inches to 22 inches wide, and travelled at a speed of $4\frac{1}{2}$ inches per second. The central position of the winding drum allowed, with a cable 328 yards long, and working convergingly, 21 to 35 acres to be ploughed.

When the soil is very stiff 28 to 32 poles only are ploughed per day.

In April, 1899, the swampy timbered land alongside the railway, between the Lincourt station and Bajac's implement yards, was trenched with a winding drum of the latter make (Bajac), yoked to two strong bullocks with single yokes, working at a depth of 18 inches, and a width of 20 inches, the plough travelled at an average rate of speed of

* Société des Agriculteurs de France, séance du 13 Fev. 1890.

3 inches per second. Lifting the plough at the end of the furrow and placing it on the sledge took from one and a half to two minutes. The winding drum also served to pull out stumps (2 feet to 2ft. 6in. in diameter) previously grubbed round to a depth of 2ft. 3in. and a width of 2 feet, after the fashion of a forest devil.

The cost of ploughing 1 acre with a horse-gin differs in each particular case. Here is, however, an example of the way of calculating it :—

A horse-gin, worked by four horses, taking, as an average, seven days to trench 2½ acres, the complete material costing £100, the annual writing off being 20 per cent. for a capital of £20.*

The daily expense of the work is :—

	s.	d.
4 horses at 4s.	16	0
2 bullocks at 1s. 7d.	3	2
2 men at 2s. 4d.	4	8
2 boys at 1s. 7d.	3	2
Total	27	0

That is to say, 27s. × 7 = £9 9s. per 2½ acres.

We may draw the following table by assuming a maximum of 200 days' work per year :—

Surface ploughed per year.	Number of days of work per year.	Cost per 2½ acres. Writing off Wear and Tear.		Work.		Totals.	
Acres.	Days.	s.	d.	s.	d.	s.	d.
12½	35	80	0			270	0
25	70	40	0	190	0	230	0
50	140	20	0			210	0
75	210	13	6			203	6

* The details of this capital are as follows :—

Writing off £100 in ten years at 4 per cent. ...	£8
Wear and tear at 12 per cent.	12
Total	£20

Representing in gross 20 per cent. of the capital (£100). In the above we do not take into consideration the interest of this capital, this latter being by a contractor pre-entered to his profit; that is to say, the difference between the price tendered and the cost of the work, *plus* general expense.

It will be interesting to compare these figures with those given later on for drums worked by steam power, to study the limits of economy of both systems.

The complete plant (drum, cable, pulley, plough) is worth from £80 to £100, which has to be written off in ten years. The steel traction cable costs from 4d. to 6d. per pound,* and weighs from 12 to 13 ounces per yard. A cable lasts from 150 to 200 days.

Under favorable conditions the cost of trenching or subsoiling 1 acre with horse-winding drums is under £6 8s.; if it exceeds this figure it is advisable to have recourse to other means for the execution of the work.

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* These prices are subject to market fluctuations.

SPECIAL SUBSOILERS.

We will study in this chapter a certain number of special machines, which cannot be classed in the foregoing groups.

In 1857 Château, a solicitor at Fontaine-Guyon (Eure-et-Loir), constructed what he termed a *subsoiling car*.* The machine resembled the frame of a dray, with two large wheels. The axle was fastened by two iron rods to a rectangular cast-iron block, provided with three stout teeth or tines 13¾ in. in length. At the end of each furrow the block, which weighed 176 lbs., could be lifted inside the frame by the aid of a rope and small windlass. In course of work, the vehicle was hauled by a team behind a plough, and, if necessary, the driver could sit upon the block and increase the weight, which would then reach 330 lbs., each tooth bearing a weight of 110 lbs. With a team of three horses the machine subsoiled to a depth of 15½ inches, "dragging out stones larger than a man's head."† In certain cases a disc for the distribution of fertilizers was fixed in front of the frame, the manure falling in front of the subsoiling teeth, which mixed it with the subsoil. In 1885, A. Derome applied the same idea to his manuring subsoiler. The Royal Society of Agriculture in England, awarded a first prize in 1850, at Exeter, in 1853 at Gloucester, and in 1854 at Lincoln, for a special machine constructed by Fowler, known as the steam mole-plough, the principle of which is similar to that of Reed-Slight's subsoiler. This mole-plough, which was exhibited and worked at the Agricultural Show at Moulins in 1869, is still in use in England, as shown in Fig. 61. It is constructed of a beam articulated in front, and provided at the rear with a handle; gearing wheels allow the beam to be raised at the end of each furrow. The working piece (Fig. 62) consists of a mole, kept at the required depth by a brace with cogs, held in position by a cotter; the inclination of the mole is given by another brace at the rear, bearing a thread and nut. A pivot is fixed in front of the beam, round which a loose pulley revolves, over which the traction cable passes hauled by a steam-winding drum. In stiff soils one of the extremities of the cable is fastened to one of the wheels of

* *Journal d'Agriculture Pratique*, 1859, vol. 2, p. 402.

† This depth of 15½ inches is evidently counted from the surface of the soil, including the depth of the preliminary ploughing. (Trans.)

the steam-engine (fixed point). The cable passes over the loose pulley of the mole-plough (Fig. 61) the other extremity winding on the drum. With such an arrangement the

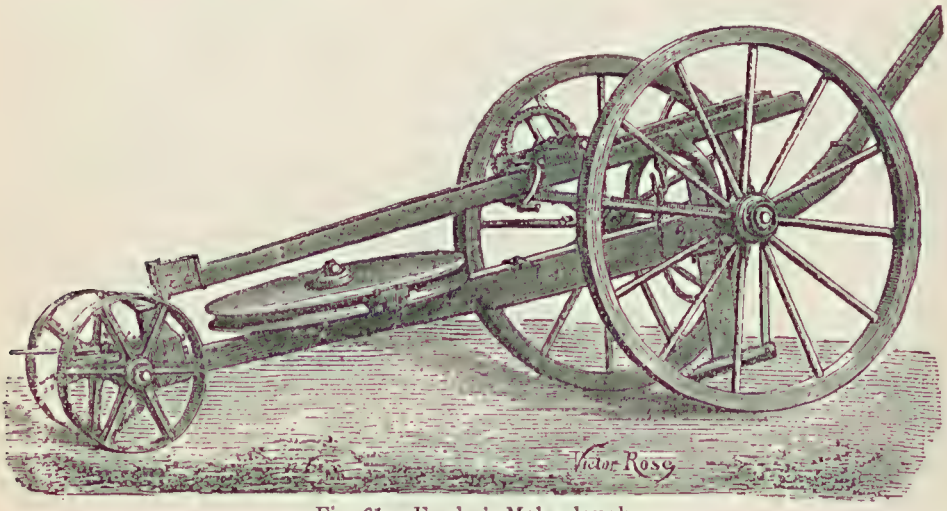

Fig. 61.—Fowler's Mole-plough.

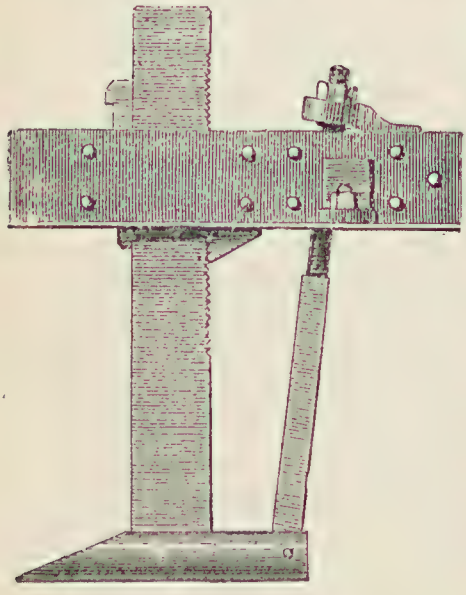

Fig. 62.—Mole of Fowler's plough.

traction on the plough is doubled, but the speed falls to half.

The work done by Fowler's machine depends on the shape given to the mole; that shown in Fig. 62 is used to make, by compression, underground drains at a depth varying from 27½ inches to 3ft. 3in. These drains last from fifteen to thirty years, and the cost is only 10s. per acre. But this kind of subsoiler can only be used in clayey soils free from stones. For ordinary subsoiling the mole may be replaced by subsoiling teeth.

Ransomes used to make a special subsoiling machine called Beauclerc's *Archimedian subsoiler;* this machine resembled that of Reed-Slight, but at the rear of the share an Archimedian endless screw was fixed revolving round an axle. According to the inventor, the strip of soil cut by the share would revolve this screw, and thus stir the subsoil, lifting it to a certain height to let it fall crumbled

behind the plough. We have not been able to find any documents on the practical work of this machine, but it is almost certain that the soil jamming in the axle would prevent the rotation of the screw. This, however, happened with similar machines exhibited since Ransomes', although great care had been taken to protect the bearings against the introduction of any particles of soil.

Subsoiling machines have been constructed on another principle, the working piece revolving in the vertical plane, the subsoiling teeth being fixed to the tire of a wheel ; such is the principal adopted by Guibal, of Castres (Tarn). We quote Londet's remarks, who witnessed many trials of this machine :—*

"Guibal's subsoiler appeared for the first time at the agricultural show held at Versailles in 1851. Subsequently the inventor added many improvements (Figs. 63 and 64). These figures show the machine as it appeared at the Universal Exhibition at Paris in 1855.

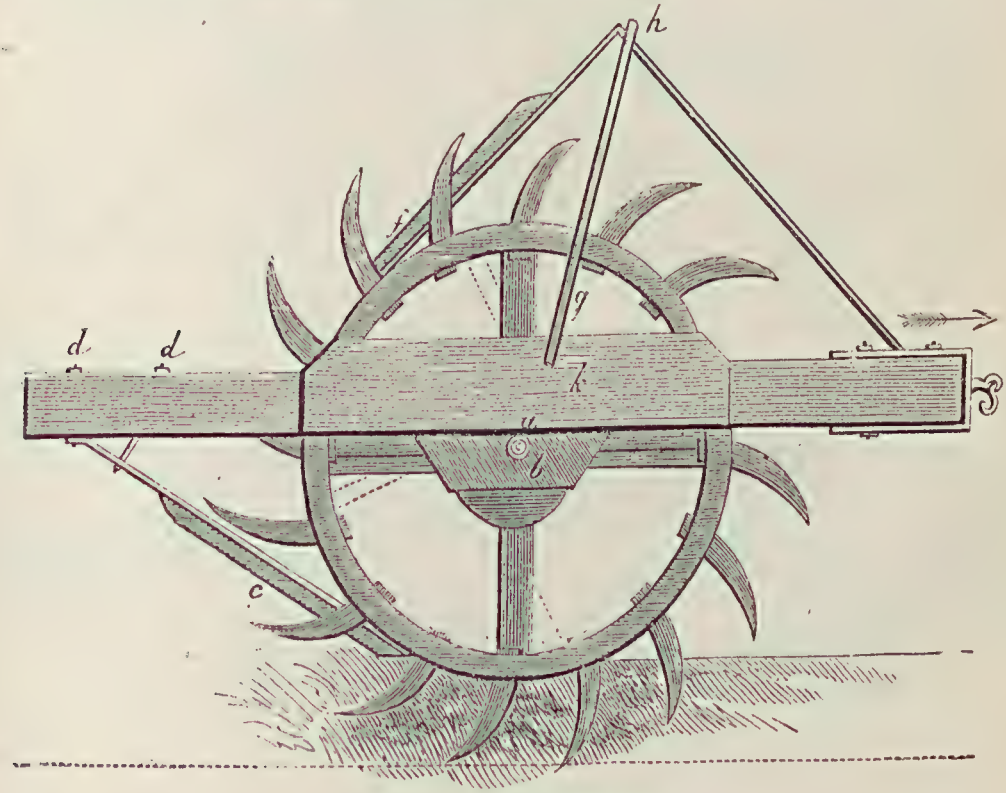

Fig. 63. - Guibal's Subsoiler.

"Guibal's subsoiler (Fig. 63) consists of a cast-iron wheel 31½ inches in diameter, provided with sixteen pairs of curved teeth, or tines, 12 inches in length.

* L. A. Londet, professor at the School of Agriculture, Grand-Jouan, *Instruments Agricoles, machines et outils* (Exhibition of 1855).

"Guibal found from experiments that the weight of the machine should be 1,056 lbs. to enable the teeth to penetrate throughout their length in soils of medium stiffness; he advises weighting by cast-iron blocks, fixed between the spokes by means of bolts, or to fix on the frame *k*, wooden cases, which may be loaded with earth (Fig. 64). The first of these two

Fig. 64.—Guibal's Subsoiler at work.

means of increasing the weight should be preferred, for the weight acts more directly on each tooth. The wheel revolves round an axle *a* fixed on the wooden frame *k* made as narrow as possible. On the rear of the frame a paddle board *c* is fixed, so as to engage between each pair of teeth, forcing the soil to fall back in the furrow directly it is raised.

"Another paddle board *f* is fixed to the front of the frame, and, engaging between the teeth, forces the soil to fall over two iron plates fixed slantingly on each side of the frame. By this means the soil is deposited on one side of the part already ploughed, on the other on the part which is to be ploughed; as a result the subsoil is disposed between two layers of arable soil. According to the nature of the soil, either of the paddle boards is used.

"A lever fixed on the axle enables the machine to be kept in equilibrium (Fig 65).

"One or two poles for the yoking of horses or bullocks completes the machine.

"In course of work the wheel revolves, the teeth penetrating the soil; the work cannot be better compared than with that of a hand hoe.

"As in the case of any other subsoiler, Guibal's machine works in a furrow previously opened by an ordinary plough. Two men and four horses are generally required. We see from this that its work costs double that of the plough. Stones, roots of trees, &c., do not handicap the work of this subsoiler.

"We have used, and also seen, Guibal's subsoiler, in use; compared against others, such as Smith's or Reed's machines, the work of the former has always been more satisfactory.

"For travelling this machine on roads ordinary wheels are fixed to the axle *a* preventing the teeth from touching the ground. We cannot end this chapter without stating that, in our opinion, it is one of the best machines, and destined to render great service in intense culture."*

Guibal's machine was very unstable; it had a tendency to tilt sideways, and had to be kept vertical by a man acting on a lever prolonging the axle. Rolland, professor at Grand-Jouan, thought of fixing two wheels to the frame, and had a machine made to his own designs for Baron Thenard, who called the machine "*digger*," and improved it in several details, notably in mounting the wheels on a bent axle, which could be raised by means of a lever. A description of it is given in the *Journal d'Agriculture Pratique*, 1858, vol. 1, p. 220.

Thenard's digger (Figs. 65 and 66) consists of two large parallel wheels 6ft. 6in. in diameter, 4 inches apart, and running loose on the axle; the spokes are made of wood, and the iron tires provided with curved tines 11 inches in length. Each wheel weighs 660 lbs. The frame is provided with a paddle-board as in Guibal's machine.

Fig. 65. – Thenard's Digger at work.

The axle, 2 inches in diameter, has two bends at right angles 11½ inches in length, and is terminated by two axle arms, upon which ordinary wheels revolve, for moving the machine about. The whole appliance is fixed

* Guibal applied the same principle to the construction of hoeing rollers, used for surface work (length, 3ft. 11in.; diameter, 21½ inches; length of teeth, 5 inches).

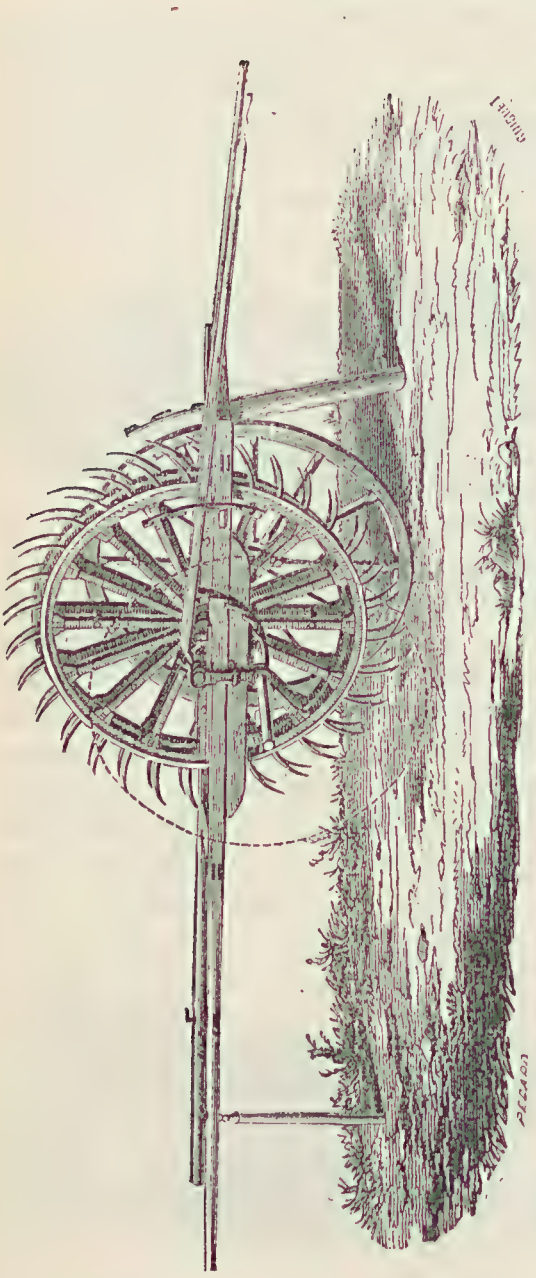

Fig. 66. - Thenard's Digger.

on a kind of dray-frame (Fig. 66). The position of the subsoiling discs with regard to the wheels, which are always in contact with the soil, is regulated by means of a bent axle. The discs are lowered or raised by means of two levers (one on each side) 13 feet in length, which can be clamped on a ratchet sector.

These levers might be replaced with advantage, by any device actually in use. The depth of subsoiling may be modified, or the disc lifted out of the ground altogether, so as to turn at the end of a furrow or for being moved about. If only one man is to lift the discs, he has to act upon each lever in turn. In the experiments one man took one and a half minutes to lift the discs, while two, acting simultaneously, only took half a minute.

With a plough working to a depth of 12½ inches followed by Thenard's digger (11 inches), the depth of cultivation reached 23½ inches.

At Baron Thenard's property, in fairly compact soil, three good horses were required to pull a plough working to a depth of 7 inches, the subsoil being very hard on account of the prolonged drought of 1858. The digger required four good horses to disturb the soil 11 inches deeper, but it was

found advisable to use five, the depth of cultivation reaching 18 inches. If we consider the above figures we are in a position to see that if we represent by ten the resistance of the unity section of the arable soil opposed to the plough, that the resistance opposed by the subsoil to the digger is eleven.

In the short days of November, doing only six hours of actual work, the area worked per day was from 136 to 144 poles. The whole plant required is the ordinary plough and team, plus five horses, a driver and two men for the digger.

Let us study the work of one tine of Guibal's machine. If the disc A (Fig. 67), has a weight P, sufficient to pre-

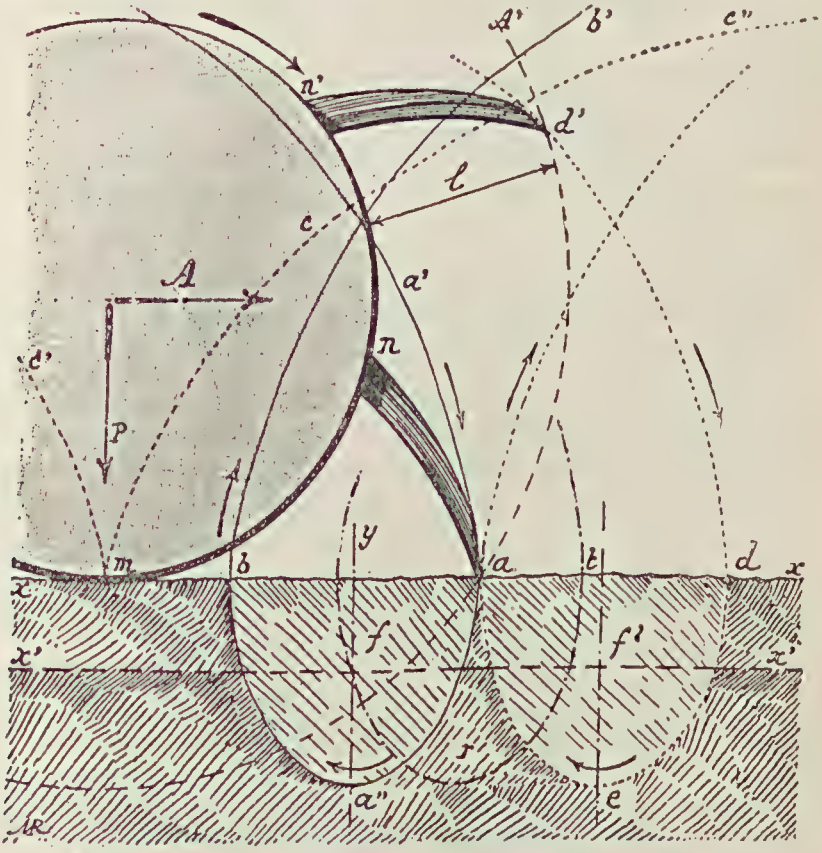

Fig. 67.—Diagram showing the work of a Subsoiler.

vent it from sliding, any point of the circumference m describes in the vertical plane a series of curves $c' m\ c\ c''$ called cycloids. If the point a is outside the circle, the trajectory described by that point is a curtate cycloid.*

* We may mention that cycloids (common cycloid, curtate cycloid, and prolate cycloid) are curves generated by a point in the plane of a circle, when the circle is rolled along a straight line, keeping always in the same plane, and possess the following properties:—In any point of the curve, the normal to that curve passes by the point of contact of the circle A with the fixed line x. For instance, for the portion $a\ a''\ b$, which interests us, the normals in a and b coincide with the plane x of the soil. In a'' the normal y is perpendicular to $x\ x$.

The point of a tine $a\ n$ describes in the soil a trajectory $a\ a''\ b$ disturbing a volume of soil represented in section by f. Practically the section worked is a little larger on account of the tearing taking place in the part $a''\ b$.

We see in diagram 67 that the profile $a\ n$ of a tine must be inside the cycloid $a\ a'$ generated by the point a. If this condition is not fulfilled, the back of the tine compresses the soil in the part $a\ a''$. This waste of power has also the disadvantage of forcing the wheel to slide on the ground.

To obtain satisfactory subsoiling it would be sufficient, after the tine $n\ a$ has disturbed the part f, for the next tine $n'\ d'$ to disturb the part $d\ e\ a$, for the zone r is torn away.

From the above it results that the distance apart $n\ n'$ of the teeth on the circumference of the disc a, must be at the maximum equal to $b\ a$ or $a\ d$. By setting the tines closer together the section r, which has to be disturbed by tearing, is diminished.

In Guibal's subsoiler the radius of the disc A was 15·7 inches, the length l of the teeth was 12 inches, the distance apart $a\ d'$ of the points was 11 inches, that is to say, the distance $a\ d'$ was $\frac{9}{10}$ of the length l of the teeth. If we draw the diagram relative to the work of Guibal's machine, we see that the teeth successively describe curtate cycloids, having within the zone of work the following dimensions :—

Chord $a\ b$	15 inches.
Arrow $y\ a''$	12 inches.
Distance apart of two successive trajectories $a\ t$	6 inches.

Under these conditions the whole depth $y\ a''$ of soil could be thoroughly disturbed.

When the weight P of the disc is not sufficient to overcome the resistance to penetration of the subsoil, a portion only of the teeth penetrates, the periphery of the disc A not being in contact with the soil. Under these unfavorable conditions the surface of the soil (Fig. 67) must be considered as being $x'\ x'$, and the zone of action of each tine diminishing in depth as well as in width, may leave, in certain cases, portions of the soil untouched.

It appears that machines built on this principle were discarded after 1860. It would be interesting to ascertain if their principle was wrong, or if the construction was defective at that period. Unfortunately we have been unable to find any literature answering this question.

We have seen that Guibal, in 1855, had applied this principle to his hoeing rollers. Since then different models have been constructed for surface ploughing. In this type of machine we may mention that of A. de Souza (1891) Morgan's pulverizer, and the mechanical hoeing machines exhibited by Messrs. Ch. Galland, Grandjon, and Co., at the Agricultural Show held at Paris in 1894.

Galland and Grandjon's digger consists of a small Guibal roller, in which each pair of steel tines is fixed in a cast-iron disc keyed on a horizontal axle, in the centre of which is a gearing wheel. On the right and left of this wheel are discs, provided with tines, and varying in number according to the width to be worked. At a distance of $31\frac{1}{2}$ inches above the level of the soil, is a horizontal axle, which a man revolves by means of two handles; this axle, by means of cog-wheels and chains, revolves the axle of the digger supported at the rear by two wheels acting as a regulator for depth. The width worked is 18 inches, the depth 4 inches. Certain models proposed for hoeing plants in a line, such as vines, are mounted on a light frame carried by four wheels. The depth worked in this case is 6 inches, and the width $21\frac{1}{2}$ inches.

Recently, in Italy, the agriculturist, Luigi Pavese, proposed a hoeing machine* which may be considered as three Guibal subsoilers, between which shovels worked by a certain movement of rotation pass. We have no precise information as to the work of this machine.

We may state, in conclusion, that the principle of Guibal's subsoiler is applied to the machine of Paul, of Norfolk (1854), used to open trenches 4ft. 10in. in depth. This machine, which is worked by a horse-gin and chains, is not within the scope of this article.

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* *La macchina Vangatrice Automatica dell' agronomo Luigi Pavese, l'Economia Rurale*, Torino, 24th November, 1899.

COMBINED PORTABLE ENGINE AND WINDING DRUM.

Displacement System.

For the trenching or subsoiling of small areas horse-gins are very cheap when the work can be done by the horses already on the place, but when the surface or area annually ploughed is over 37½ acres, it is advisable to work the winding drum by a steam-engine, especially if the latter is already on the property. Contractors for thrashing or chaff-cutting may in the same way use their engine to do trenching or subsoiling by contract. The first systems originated from Howard's machine, used formerly for ordinary shallow ploughing; subsequently constructors aimed at making machines which could be easily displaced at each furrow.

As a rule, the intermediate shaft of the winding drum is revolved by a belt or chain connected with the pulley of the engine; a gearing system being interposed between the shaft and the drum. A special device is attached for throwing in or out of gear without stopping the engine. There are often different arrangements of cog-wheels keyed on the intermediate shaft of the winding drum, allowing two or three rates of speed to be obtained. The length of the cable varies between 274 and 328 yards.

When the plough is to be hauled back by the engine, a second winding drum is attached to the system, revolving at a speed three or four times greater, the length of the hauling-back cable being 547 yards.

These different systems of winding drums are made so as to be connected to any kind of engine, which presents some difficulty in the case of direct traction. We will quote some examples later on. For a direct traction arrangement, the portable engine must be connected to the winding drum so as to form a rigid system, the whole being displaced at each furrow, while, in the stationary arrangement the portable engine is fixed at a certain distance from the winding drum, as in the case of a chaff-cutter or thresher. The stationary steam plants require fixed pulleys, as in the case of stationary gins.

The displacement of direct traction steam combinations along the headland is done by means of levers or small hauling

cables, 98 feet in length, fixed to an anchor. A man passes the small cable over a pulley fixed on the frame, and pulling backwards readily displaces the system, as it travels easily on rollers and rolled joist iron girders. These girders must be sunk in the ground. If it is too hard, they require to be steadied by means of pegs.

The drums must always be provided with brakes (automatic or otherwise) to steady the unwinding of the cable; if not, the latter, unwinding by jerks, becomes entangled in the different parts of the machine, and occasions great loss of time. The most simple automatic brakes consist of a weight, which may be displaced along a lever, at the end of which a shoe is fixed, compressing against the flange of the drum.

Stationary winding drums are generally made with a vertical shaft, so as to allow the cable to unwind in different directions, without requiring an arrangement of pulleys, but this requires the use of bevel pinions to transmit the movement from the engine to the drum. In the direct traction system the drum generally revolves round a horizontal shaft, the cable winding with or without the aid of a pulley arrangement, according to the direction of the traction.

Finally, for travelling on roads, the drums are usually mounted on four wheels.

Guyot's winding drum (Fig. 26, page 51) consists of a large rectangular frame, made of rolled joist iron girders, upon which the portable engine is carried; the fly-wheel of the latter is connected by means of a belt to the pulley of the capstan, which is fixed at the other extremity of the frame. A pinion is keyed on the shaft of the pulley, gearing with a cog-wheel keyed on another shaft, together with another pinion, gearing with the large crown-wheel of the drum upon which the cable winds direct.

The large frame is carried by four rollers, travelling on rolled joist girders. The displacement of the system is easily managed by means of levers*; the latter may be inclined at an angle to allow the system to turn about if the headland is not straight, or at the end of the headland, in order to plough it.

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* Guyot tried to displace the system automatically by means of a belt, pulleys, and gearing system, revolving the axle of the rollers when required. This complicated mechanism (1891) has been discarded.

To haul the engine on the frame, a wooden inclined plane is placed at the end; the drum worked by hand serves to haul the engine into position.

The work of one of these winding drums on the property of L. Perrière, at Salauze (Aude) was followed by P. Castel, engineer, who published an account in the Bulletin of the *Société centrale d'agriculture de l'Aude*. From his account we condense the following :—

The drum was worked with a 7 H.P. engine, consuming 343·2 lbs. of coal in ten hours, costing 21s. 2d. per ton ; in a day of ten hours the engine required 220 gallons of water.*

The drum was 19·7 inches in diameter, 35·4 inches in width; the cable 0·63 inches in diameter, 274 yards in length. The plough was hauled up a hill in compact soil, composed of pebbles and clay ; the bottom of the block was sandy and light. The furrow was 24 inches deep and 27½ inches in width. At the bottom of the block the depth was 27½ inches. The average speed of the plough was 12 inches per second.†

The furrow was 265 yards in length ; on the engine side the headland was 20 feet in width ; on the opposite, 11 feet.

At the end of each furrow two men lifted the plough, ready to be hauled back, this operation taking one minute ; a pair of bullocks took the plough back to the bottom of the block, where one man was sufficient to put it into position. Two men attended the engine and drum, displacing it while the plough was being hauled back.

The time required to open a furrow was :

Work of the plough	11·5	minutes.
Lifting the plough for hauling back	1·0	„
Hauling back	2·5	„
Placing in position	0·5	„
Total ...	15·5	„

According to this, 232 poles may be ploughed per day of ten hours.

At Salauze 34 furrows only were actually ploughed, equivalent to 208 poles.

* These figures for 7 H.P. give per H.P. per hour 48·4 lbs. of coal, 3·74 gallons of water ; 2·2 lbs. of coal therefore vaporizes about 1·76 gallons of water.

† The weight of the system, which is 7,400 kilos (7 tons 5 cwt.) (frame and drum 3,000 kilos, portable engine 3,800 kilos, water in the boiler 600 kilos) is sufficient to prevent it from sliding under the action of the traction.

P. Castel estimates the expense of the material and the expense of working this arrangement at—

Cost of material—

7 H.P. portable engine	£232
Frame, capstan, accessories	120
Cable	10
Plough	28
Total	£390

In round numbers, £400, which he estimates must be written off in five years, that is to say, £80 divided over 200 days work per annum, that is to say, 8s. per day of work.

The interest on the capital at 5 per cent. represents 2s. per day, which increases the fixed cost per day to 10s.

The daily expense is—

Fixed cost		£0 10 0
Engine-driver, boarded ...	£0 4 9	
Workman	0 2 4½	
Ploughman	0 2 4½	
Pair of bullocks and driver ...	0 4 9	
343 lbs. of coal at £1 1s. 2d. per ton	0 3 6	
Lubricating oil	0 0 5	
		0 18 2
Total ...		£1 8 2

If the plough works 160 poles per day the cost of ploughing 1 acre to a depth of 24 inches is £1 8s. 2d., out of which 18s. 2d. represent labour.*

The pair of bullocks may be dispensed with by hauling the plough back with a small cable passing over a fixed pulley anchored on the opposite headland, winding round a small drum keyed on one of the intermediate shafts.

In systems such as that above described, the action of the drum being perpendicular to the direction of the furrow, the cable does not need to pass over a pulley arrangement. With the object of diminishing the width of the headland the axle of the drum is sometimes placed parallel to the direction of the furrow; in this case the cable passes over a pulley arrangement.

* In this estimate the keeping in repair, carriage of water and coal, is not mentioned.

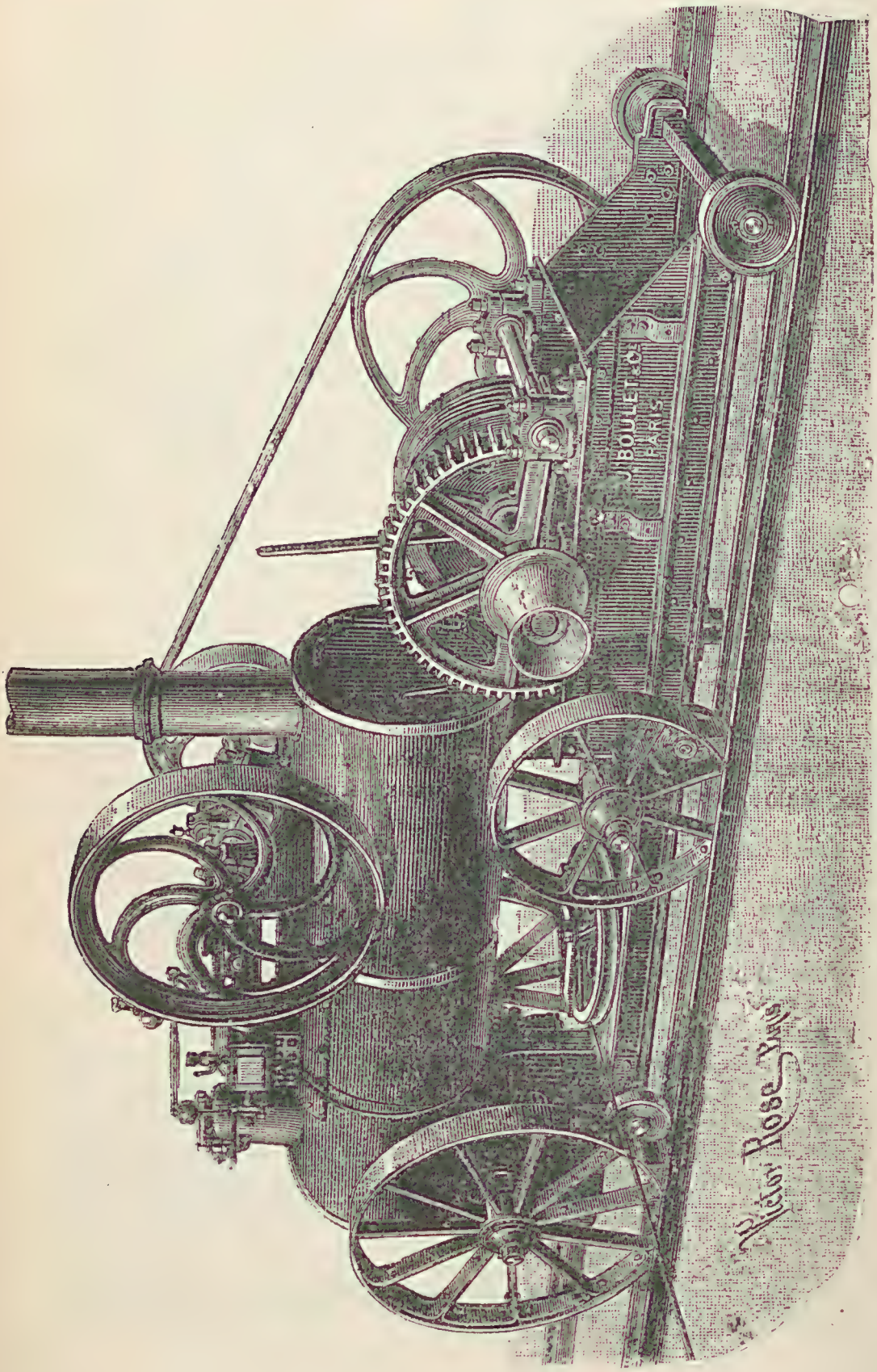


Fig. 68.—Steam Winding Drum of Boulet, Brûlé, and Co.

Such an arrangement is shown in Plate VIII.

This winding drum was exhibited by Boulet, Brûlé, and Co., at the Agricultural Show held at Paris in 1892. It may be attached by means of iron straps in front of any portable engine; the cable passes over a horizontal pulley fixed upon the frame of the drum under the engine. The whole system travels on rails, the displacement being effected by a small capstan fixed in front of the frame of the drum, operating on a rope anchored in the line of advance. Fig. 68 represents a machine with a single drum, the plough being hauled back by a team. In certain cases, as we shall hereafter see, two drums may be used, one of these serving to haul the plough back, opening a furrow at the same time if a balance-plough is being used.

Systems in which the plough is hauled back with a smaller cable are numerous. We will only mention two examples. To keep the two cables apart a fixed pulley B (Plate VIII.) is anchored at some distance in the field. The drum A winds the traction cable *t*, passing over the pulley *a* and fastened to the plough C; the return cable winds over the drum R, after passing over the pulleys B and *b*. The engine M and the pulley *n* are displaced after each furrow in the direction of arrows 1 and 2, the pulley B remaining stationary while a certain number of furrows are turned.

Fig. 69 represents Pelous' system; on the frame A, mounted on four rollers *g*, the portable engine M is placed; a toothed-wheel, gearing with a chain *m*, is keyed on the main shaft of the latter. The intermediate shaft of the winding drum gears directly with the drums L and R, on

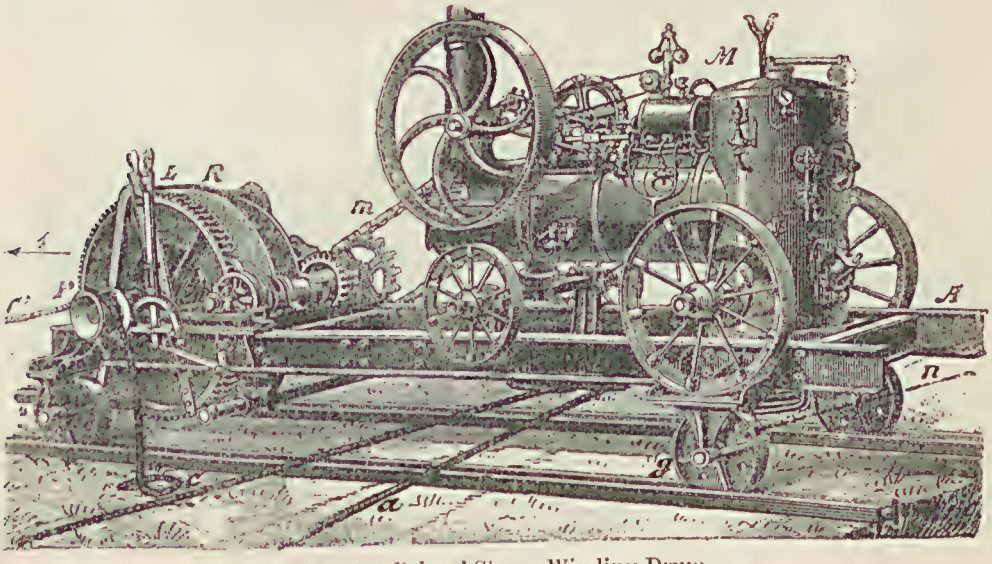


Fig. 69.—Pelous' Steam Winding Drum.

which the cables wind, after passing over the horizontal pulleys keyed under the frame A (in the Figure, a is the traction, and x the return cable). The displacement of the machine in the direction of arrow 1 is effected by the cable C C′, which is coiled two or three times round the surging drum, and held taut by the engine-driver; the other extremity of the cable being anchored at a certain distance, the whole system may be moved towards it. The displacement may also be effected by means of levers n inserted in holes in the rim of the rollers.

In the Hidien system (patented November, 1897) instead of mounting the engine on the frame of the winding drum, the latter H (Figs. 70 and 71) is put in the place of the

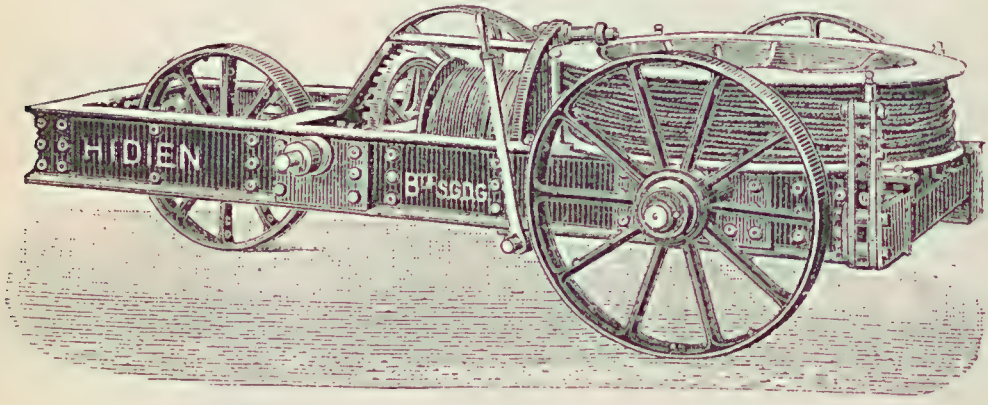


Fig. 70.—Hidien's Winding Drum.

forecarriage of the engine M, the motive power being transmitted by the belting n to the intermediate shaft, upon which a double bevel-wheel and pinion are fixed, the large wheel of which revolves at the same time both the traction drum A and the return drum R, the large drum revolving round a vertical spindle to facilitate winding; the whole system travels on rolled joist girders.

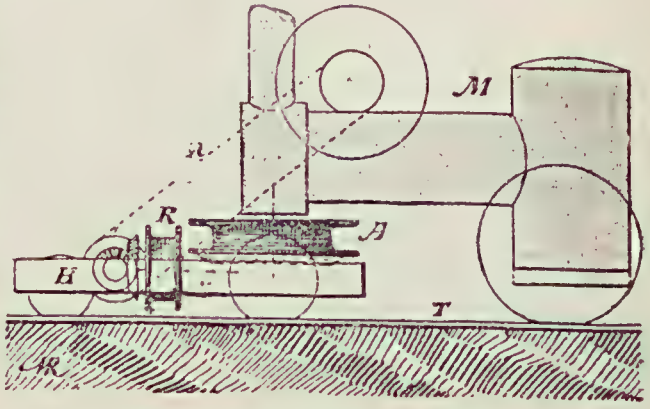
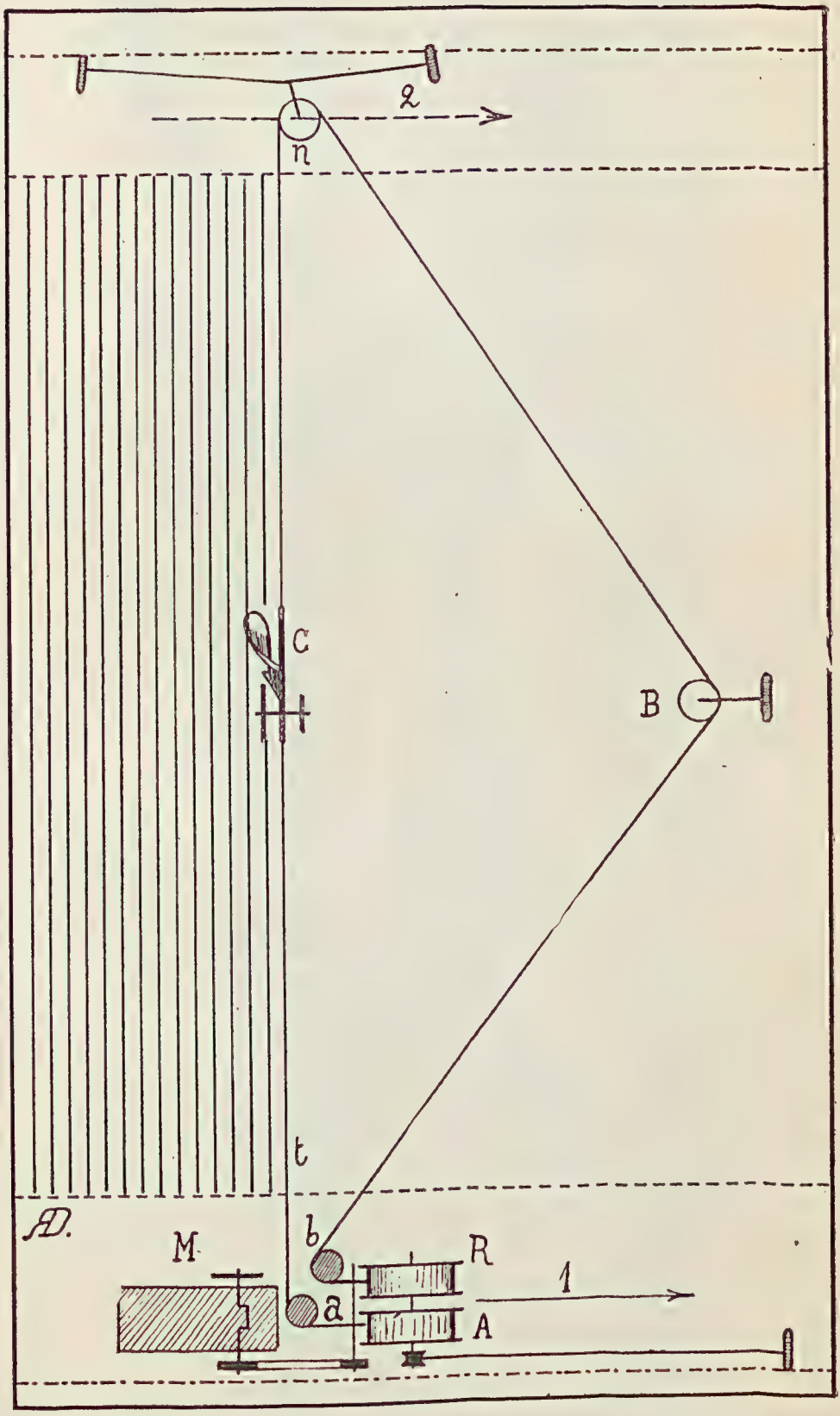


Fig. 71.—Diagram of Hidien's Steam Winding Drum.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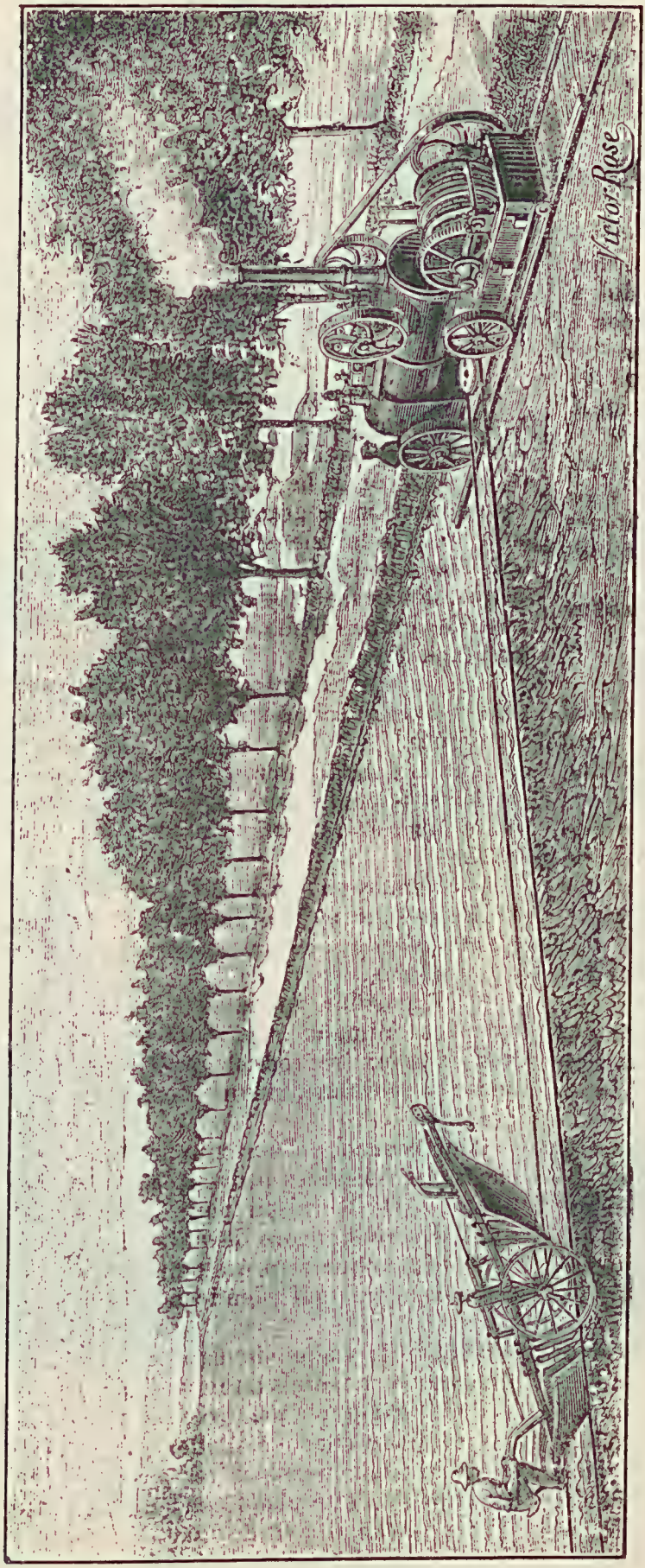


Fig. 72.—System with two Traction Drums at work.

Systems with two traction drums, drawing a balance-plough backwards and forwards, are in use. One of the cables passes over a pulley fixed on the opposite headland. Fig. 72 represents one of these at work. In this system the two winding drums are of equal diameter, but that winding the return cable is wider as it has to accommodate double the length of cable.

Combined Portable Engine and Winding Drum.

Stationary System.

When the system is fixed stationary in a given position in the field, the old Howard system (shown in Figs. 73 and 74) may be adopted. The two drums run loose on a shaft fixed on an eccentric ; a lever allows the cog-wheel of each drum to be raised and thrown into gear with the pinions keyed on the intermediate shaft, carrying the belt pulley. When the drum is thrown out of gear, its flange rests on the shoe of the brake, which is kept in position by a counterpoise (not shown in this figure). The frame of the drum is carried by two wheels. The shafts of the frame are attached to the rear of the engine, the cables passing under the platform where the engine-driver stands, then over the two pulleys fixed on a special frame bolted on the forecarriage of the machine. Plate IX. shows the working installation.

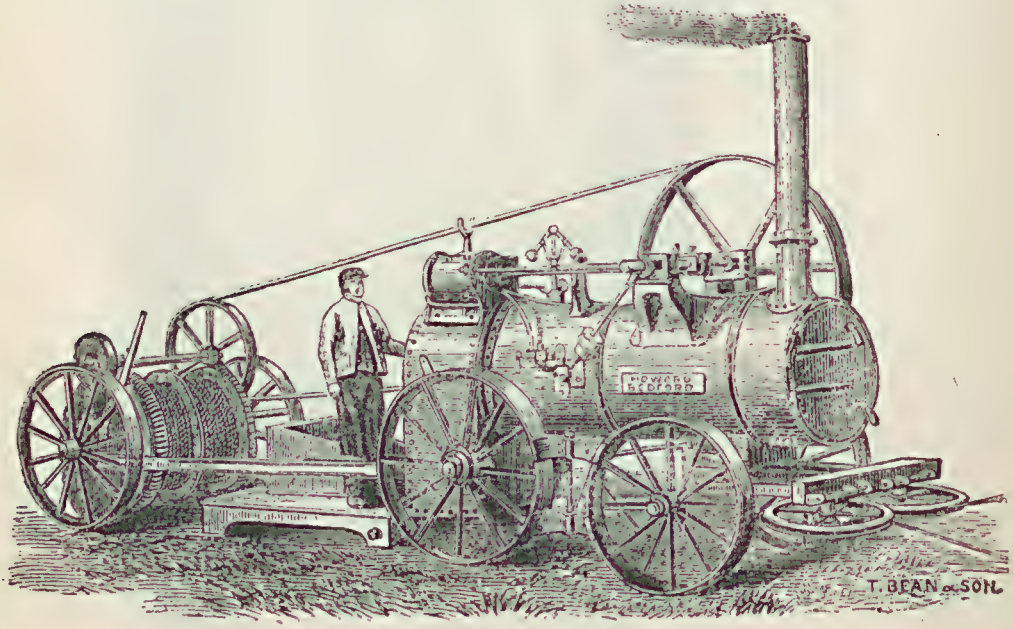
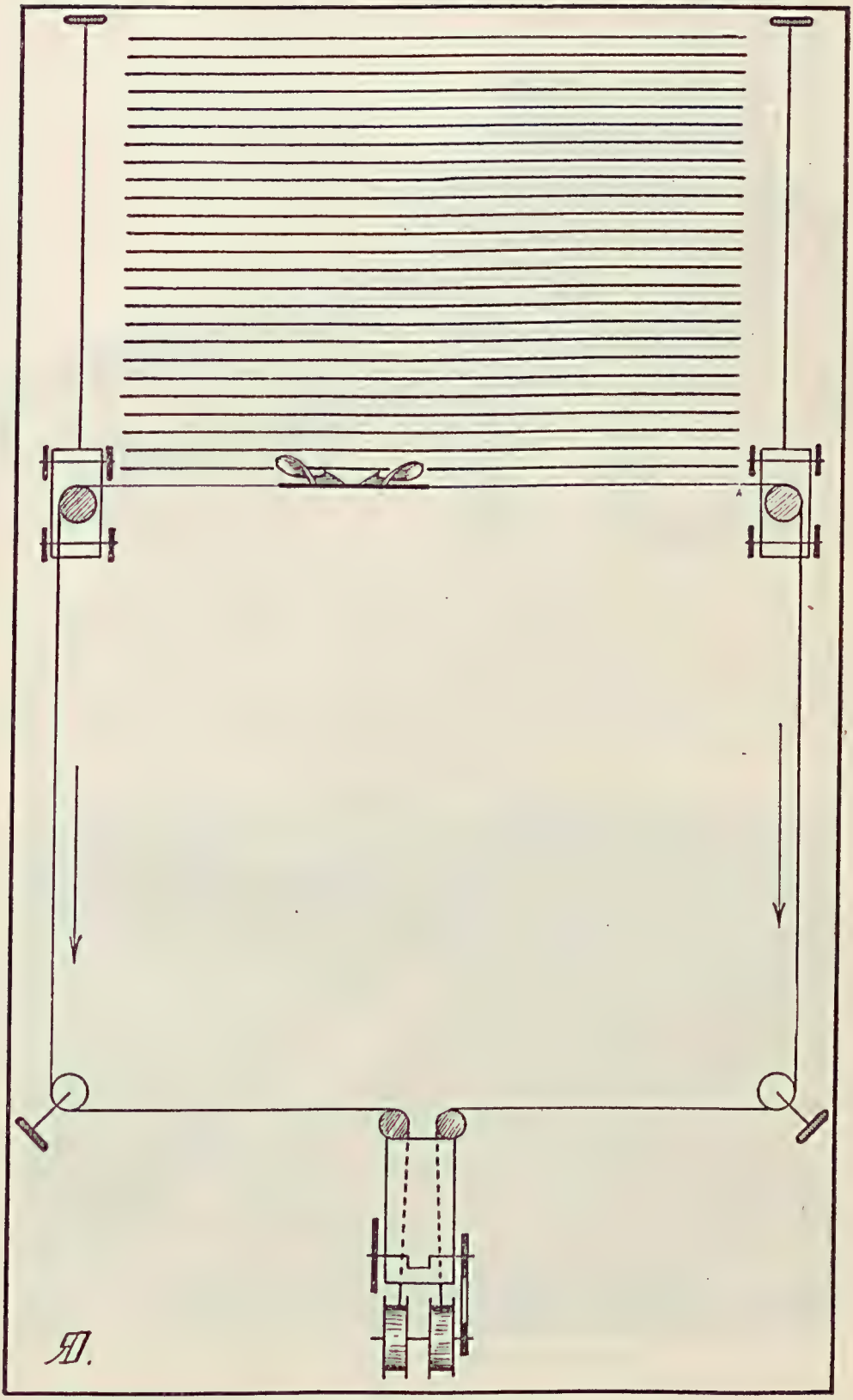


Fig. 73.—Howard's Winding Drum worked by a portable engine.



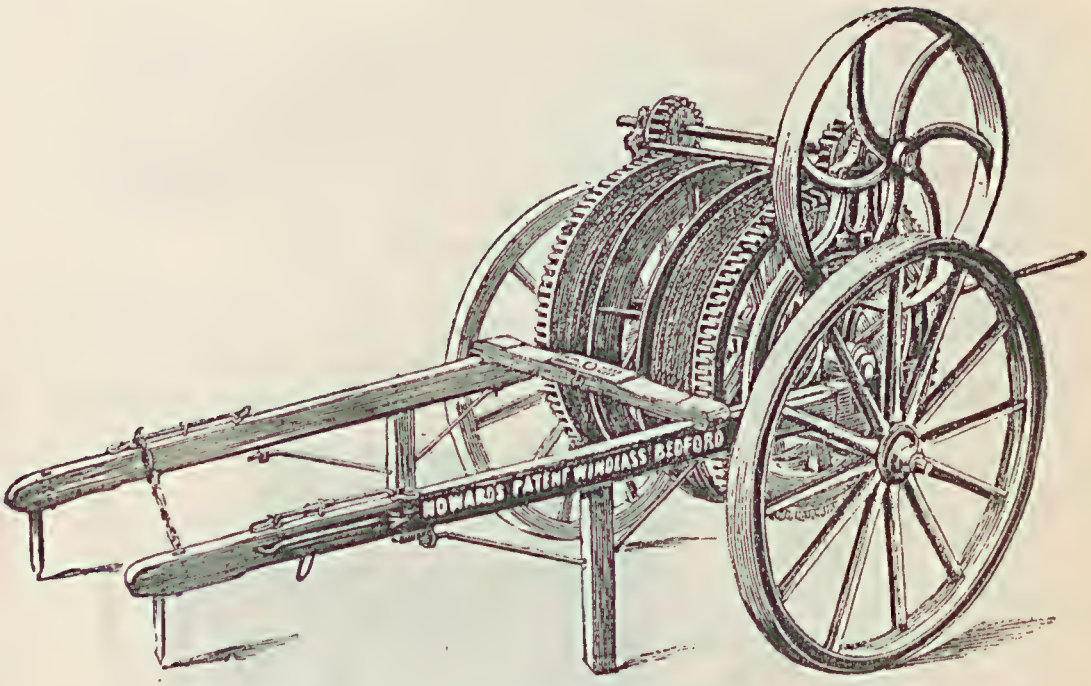


Fig. 74.—Howard's Winding Drum.

The same system, only with a single drum, was used by Gustave Scribe in 1877 to subsoil, to a depth of 24 inches, 75 acres of land near Gand.* Fig. 75 shows a general view of the plant, consisting of a portable engine, a winding drum, a pulley fixed on a long wooden frame, on the end of which is

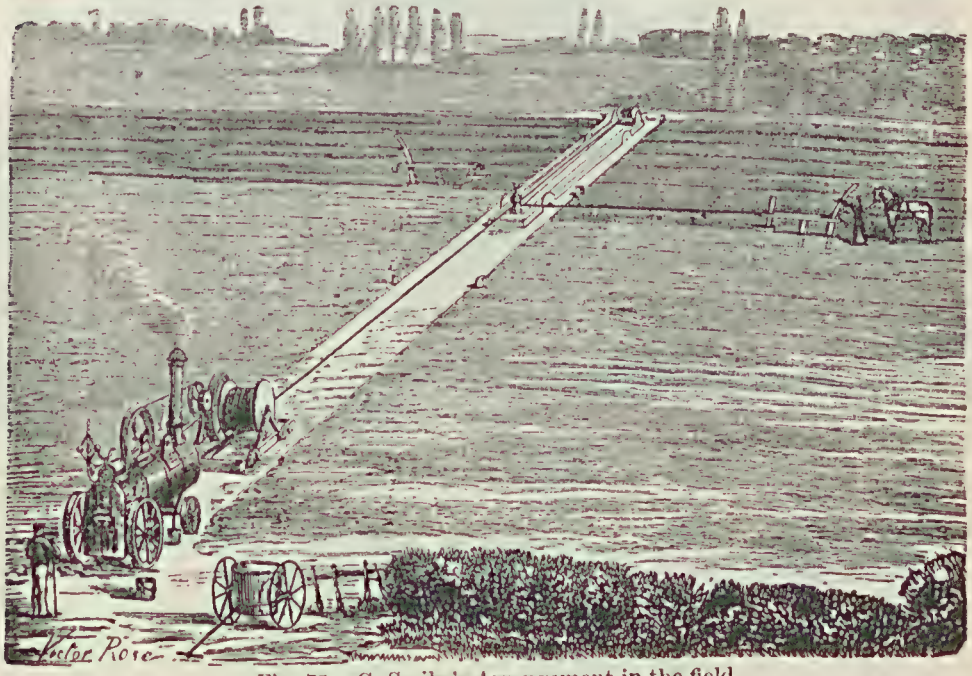


Fig. 75.—G. Scribe's Arrangement in the field.

* *Journal d'Agriculture Pratique*, 1897, vol. 1, p. 829.

a small windlass, which, by unwinding, allows the pulley to be drawn towards the engine. The subsoiler only worked in one direction, a horse drawing it back with a cable 274 yards long. Seven and one-half acres could be ploughed without shifting the engine. Gustave Scribe wished to apply this system to the polders of Zealand, where stiff soils 4 feet in depth are only ploughed to a depth of 9½ inches.

The winding drums in actual use (Vernette, Guyot, Amouroux) generally rotate vertically, when the plough is to be hauled back by a horse. Figs. 76 and 77 represent Vernette's winding drum mounted on wheels for travelling on

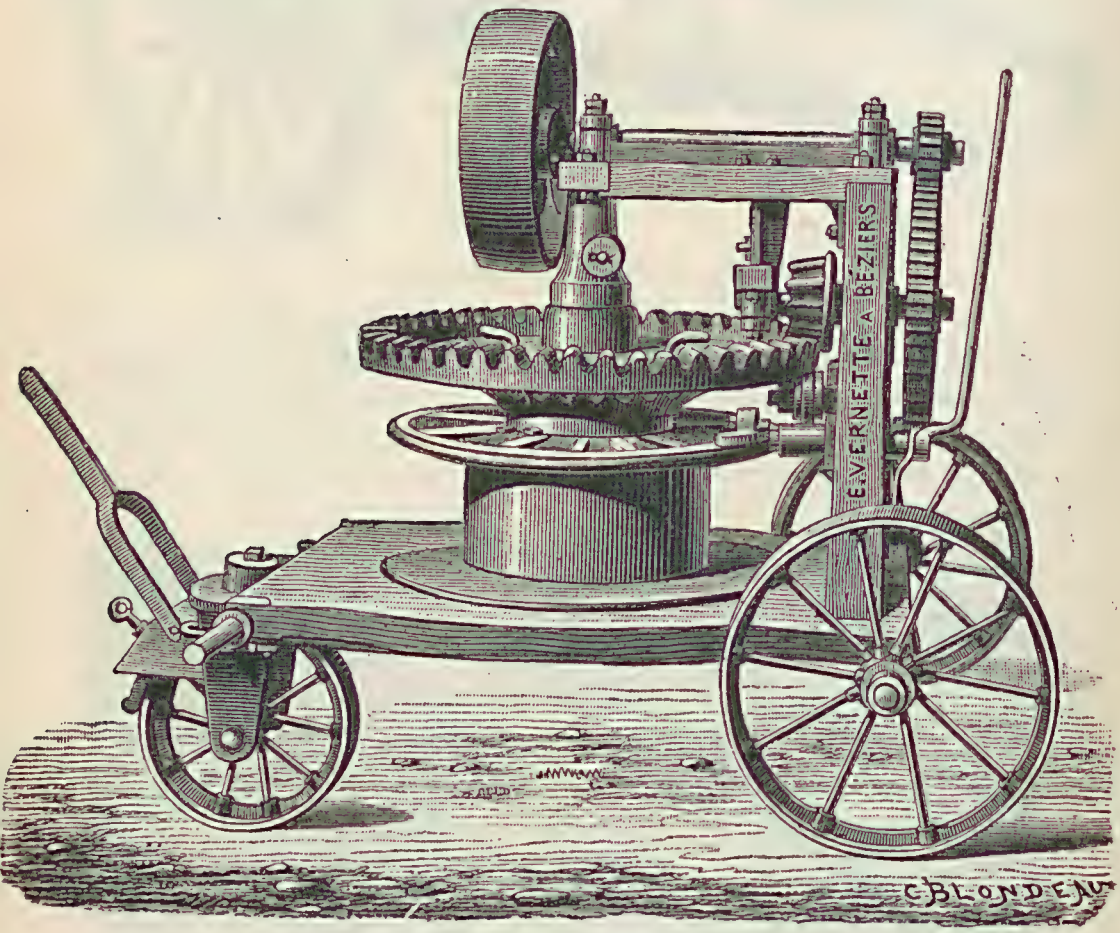


Fig. 76.—Vernette's Winding Drum.

roads. In work, the wheels are removed, and the machine fixed on the ground. A belt connects the pulley of the engine to that of the winding drum. Different gearing systems may be interposed between the pulley and the drum to modify the speed.*

* In the old model, the transmission of the shaft of the pulley to that of the drum was made by means of a spiral gearing. This system was applied by Grué in 1891.

In the old Beauquesne winding drum there were two cog-wheels and two pinions, which varied the speed according to their position.

We have already described Pelous' convertible horse or steam-power winding drum (Fig. 53, p. 87).

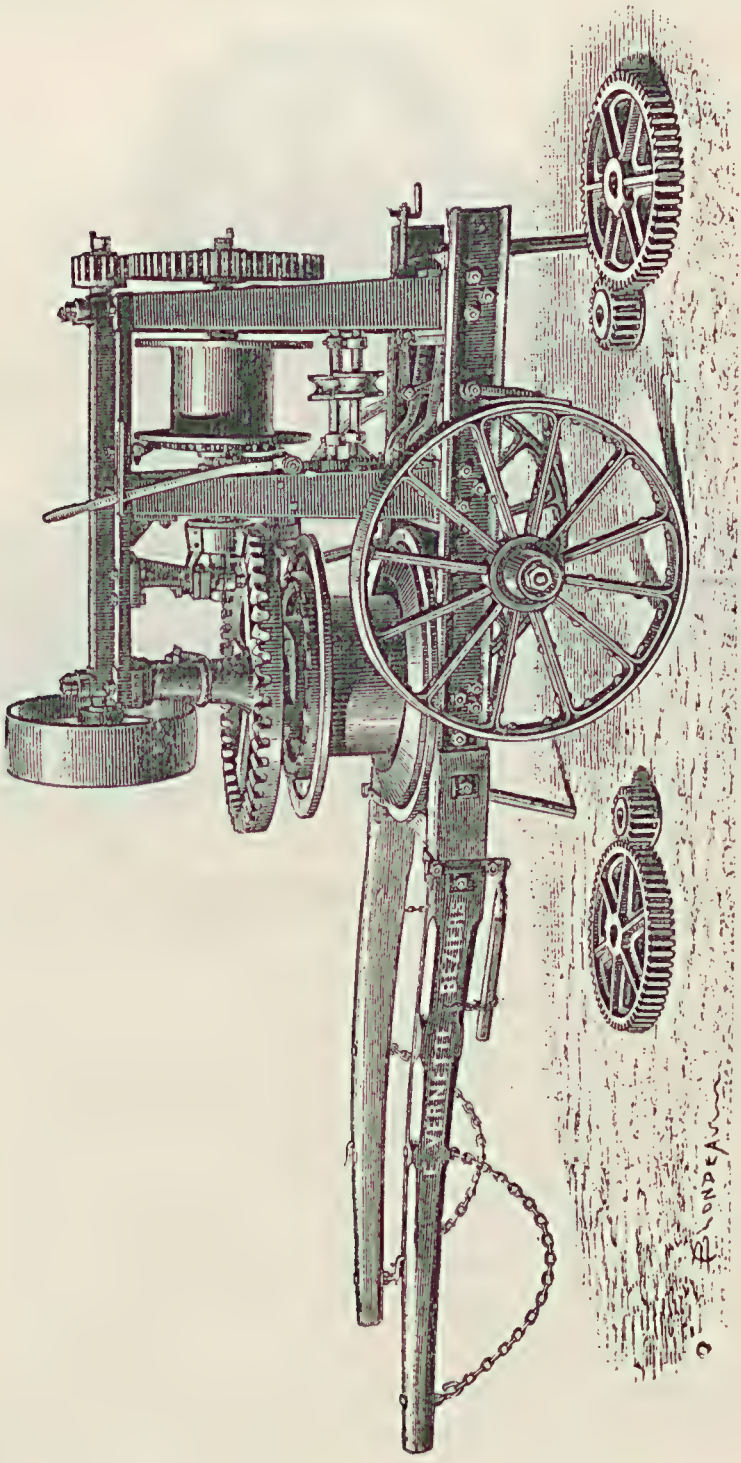


Fig. 77.—Vernette's Winding Drum, latest pattern, with Return Drum.

Fig. 78 represents a stationary winding drum with a small drum for the return cable (Pelous). The shaft of the pulley bears a bevel pinion, gearing with a bevel cog-wheel on a vertical shaft, bearing a double cog-wheel which may be alternately thrown into gear with either drum by means of a lever.

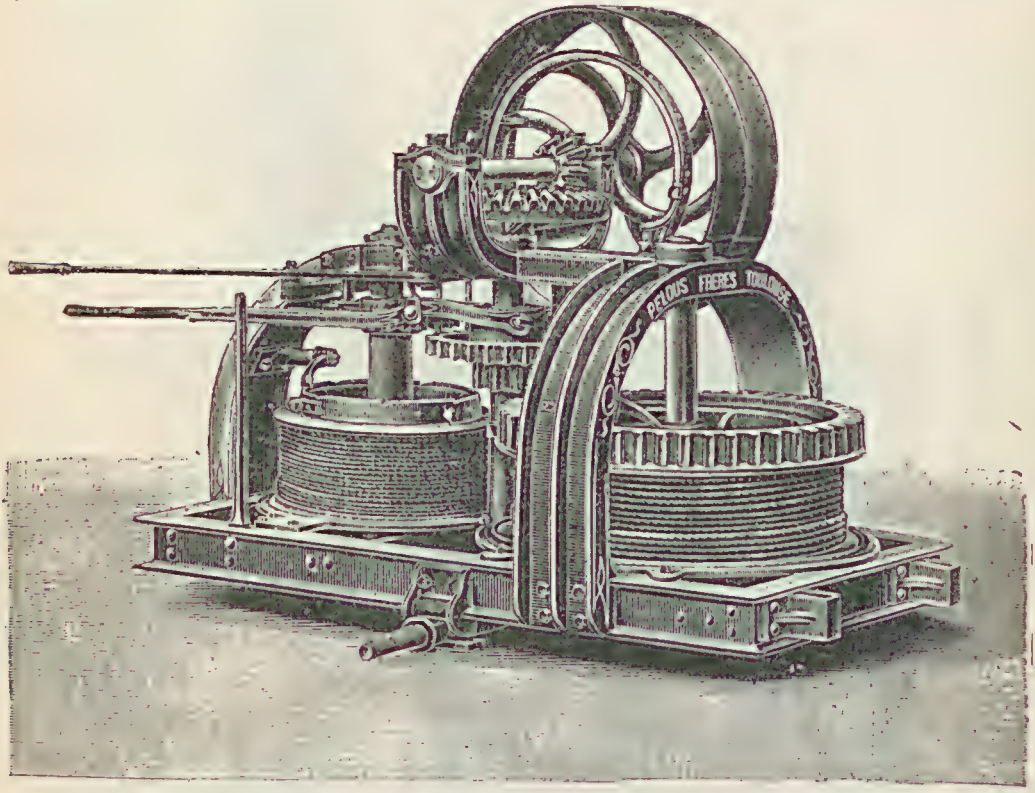


Fig. 78.—Pelous' Capstan with Drum for the Return Cable.

With a Beauquesne simple winding drum, as worked with an 8 H.P. portable engine at Mr. Deltil's property at Saint-Sulpice-de-la-Pointe (Tarn)*, the work practically done has been 3 furrows 219 yards in length, 19½ inches in depth, and 27½ inches in width per hour, *i.e.*, 16·8 poles per hour.

From many observations we may admit in practice the following figures relative to the analysis of a day's work :—

	Ratio.
27 per cent., meals and rest	43·4
11 per cent., anchoring and ordinary stoppages during work	17·7
62 per cent. useful work (ploughing and hauling back)	100·0

We may compare simple effect against double effect winding drums, working a balance plough backwards and forwards,

* *Journal d'Agriculture Pratique*, 1889, vol. 1., p. 578.

in the case where both are worked by steam. By taking the figures corresponding to the conditions we indicated for drums worked by horse power, we obtain the following results, limiting the duration of work to 200 or 210 days per year :—

Description.	Winding Drum.	
	Simple Effect.	Double Effect.
General Items—		
Cost of complete material*	£400	£600
Writing off in ten years, cost of repairs estimated at 20 per cent....	£80	£120
Power of the engine	8 H.P.	10 H.P.
Coal consumed per day	704 lbs.	880 lbs.
Time required in practice for the ploughing of 1 acre	$2\frac{2}{5}$ days	$1\frac{4}{5}$ day
Cost of work per day—		
1 engine-driver	4s. 9d.	4s. 9d.
2 workmen, at 2s. 4½d.	4s. 9d.	...
3 men, at 2s. 4½d.	...	7s. 1½d.
1 pair of bullocks for hauling back	4s. 9d.	...
Coal, at £1 12s. per ton	10s. 1d.	12s. 8d.
Oil, grease, and cottton waste	1s. 7d.	2s.
Transport of water and coal, 2 bullocks and 1 man, for a few hours	4s. 9d.	4s. 9d.
Total	30s 8d.	31s. 3½d.
Cost per acre	£2 9s. 3d.	£1 18s. 0d.

Area ploughed per Year.	Number of days worked per Year.	Cost per Acre.			Number of days worked per Year.	Cost per Acre.		
		Amount written off and Repairs.	Work.	Total.		Amount written off and Repairs.	Work.	Total.
		£ s. d.	£ s. d.	£ s. d.		£ s. d.	£ s.	£ s. d.
25 acres	40	3 4 0	...	9 8 9	30	4 16 0	...	9 11 0
50 ,,	80	1 12 0	...	7 16 9	60	2 8 0	...	7 3 0
75 ,,	120	1 1 4	6 4 9	7 6 1	90	1 12 0	...	6 7 0
100 ,,	160	0 16 0	...	7 0 9	120	1 4 0	4 15	5 19 0
125 ,,	200	0 12 8	...	6 17 5	150	0 19 2	...	5 14 2
150 ,,	...	...	...	...	180	0 16 0	...	5 11 0
175 ,,	...	...	...	...	210	0 13 10	...	5 8 10

* We assume in this case the engine to be solely used for this work, and bearing all the cost of writing off.

This table (which may be modified according to circumstances) shows that when an area exceeding 70 to 100 acres is ploughed annually, it is more economical to use a double-effect drum hauling a balance-plough. We will have an opportunity later on of comparing these figures with those of the steam winding drum engine (Fowler) often used by contractors.

III.

PRACTICAL INSTRUCTIONS REGARDING THE USE OF STEAM WINDING DRUMS FOR PLOUGHING AND TRENCHING.*

By A. Debains.

The necessity of reconstituting vineyards destroyed by phylloxera, attracted the attention of viticulturists to all systems of powerful appliances capable of disturbing land deeply. *Deep stirring of the land is, as a matter of fact, absolutely necessary to success in planting American vines*, to allow their roots to penetrate into the lower layers of the disturbed soil, which retains the rain water of the winter, preserving the roots against the detrimental effects of summer droughts. Many viticulturists, when their trenching or subsoiling is finished, abandon their winding drums without any care under sheds, &c., where they rust and soon become only fit for sale as old iron. If, on the contrary, these machines are well looked after, and kept in repair, they may be used for ordinary hoeing and ploughing of vines, as we will show further on; and later on, when it is desired to plant vines again they may be used as originally intended.

To thoroughly understand the management of a winding drum, and to utilize it to the utmost, we must have a good knowledge of the different parts of which it consists. We will study these briefly. We will not study here the heavy powerful double-effect steam winding drums, which are only used on large properties or by contractors. The practical machine for a medium grower is that which can be worked by an ordinary portable engine, as usually found on a farm, in use for pumping water, chaff-cutting, threshing, sawing wood, &c. With the object of simplifying the system and reducing the initial outlay, vine-growers almost blindly rushed after simple-effect drum machines, that is to say, those in which the plough is hauled back by a horse. If this system may be applied to cheap drums worked by a horse, it is no longer rational when steam-power is used, and if the advocates of the simple drums bring forward the argument of the difficulty or even the impossibility of anchoring the

* *Revue de Viticulture.*—Vol. III., 1895.

fixed pulley, that is simply a confession of their ignorance as to the methods of effecting it, and we will insist on the essential conditions, which are simple and practical to anyone who has knowledge of that kind of work.

With the object always of reducing cost, implement makers when constructing double-effect winding drums only use a small simple pulley for the return cable. This pulley is kept in position by means of a chain made with large links, through which a peg, passing through the links of another chain, is fixed in a direction parallel to the opposite headland. The latter chain must be securely fixed at both extremities to anchors or wooden beams held by pegs. When the plough has opened two or three furrows, the peg is taken out, the pulley and the cable shifted by hand, which requires considerable effort, especially if the ground is wet; the peg is then replaced in another link of the chain. The latter must be securely anchored, as the effort it bears is double that of the direct traction, but, as implement makers seemingly wanted to increase the difficulties of anchoring, they made pulleys too small in diameter, and supported by a too narrow plate, which tends to come out of the ground when the plough starts. This system can only work satisfactorily with pulleys of a very large diameter, revolving on a very wide plate of wood or iron, but then it is heavy, and consequently difficult to move by hand.

The best method of securing the return cable is undoubtedly a large pulley, supported by a truck, provided with four steel discs cutting into the ground and preventing sliding. Plate X. shows the solution of this difficulty. It is certainly rather expensive, but it enables the work to be done easily without stoppages, a greater area to be ploughed, and consequently the cost per acre reduced.

The engine, behind which is the winding drum carried on its frame, travels against one of the boundaries. A pulley is anchored at a distance of 109 yards in front. The automatic anchor, having in its centre a large pulley, travels on the opposite headland. A third pulley is anchored in front of the automatic anchor. The winding system is made with two drums, one hauling the plough directly from the automatic anchor towards the engine, the other pulling it back after passing over the three pulleys. With this arrangement the strain on the automatic anchor is only one of the

A.

components of the total traction, if the soil is dry this automatic anchor cannot slip, as it is kept in the soil by the discs cutting into it; and, if its weight is not sufficient, it may be increased by means of boxes filled with earth. If the portable engine and winding drum carriage are carried on iron rails, allowing easy displacement by block and tackle, the fixed pulley in front may be dispensed with, and the cable passed over the pulley in front of the automatic anchor, but in this case the pulley must be secured by two or three anchors, for, the angle of the cable being more acute, the strain on the pulley is greater.

The system being established as above, or in a similar manner, it remains to study the conditions which the different parts are to fulfil to obtain the best work. We will first study the winding drums. In double-effect systems one cable winds over one drum hauling the plough, while the other cable unwinds. This unwinding is irregular, especially if the soil is dry and stony. The plough proceeds by jerks; the return cable unwinds spasmodically, and may get entangled between the flanges of the drums or the gearing mechanism. To avoid this trouble the drums must be provided with brakes, acting slightly but steadily during the unwinding. One of the simplest systems of brakes is that shown in Fig. 79. It is made of a circular band of flat iron *e* terminated at both ends by two pieces at right angles, carrying at their extremities two threaded holes in which a thumb-screw V works. The flat iron bar carries inside wooden shoes *b*, and outside cleats *t*, rounded on one side and flat on the other. The shoes *b* rest on a circle provided with a flange fixed on the drum T or cast with it, upon which the pressure of the brake acts. When the drum T revolves in the direction of the arrow (position 1), that is to say, unwinds the cable, one of the cleats *t* comes in contact with the stop *m*, held in position by a cast-iron support bolted on the frame, and the brake acts. If, on the contrary, the drum T revolves in the opposite direction (towards the plough), one of the cleats *t* comes in contact on its rounded part with the stop, which is lifted (position 2), and the brake does not act. The lever *k* allows the stop *m* to be lifted by hand, and the brake to remain free. This is done when a certain length of cable has to be unwound by hand.

It is also necessary to make the hauling cable wind regularly round the winding drum. Most of the winding drums on the market are not provided with winding guides;

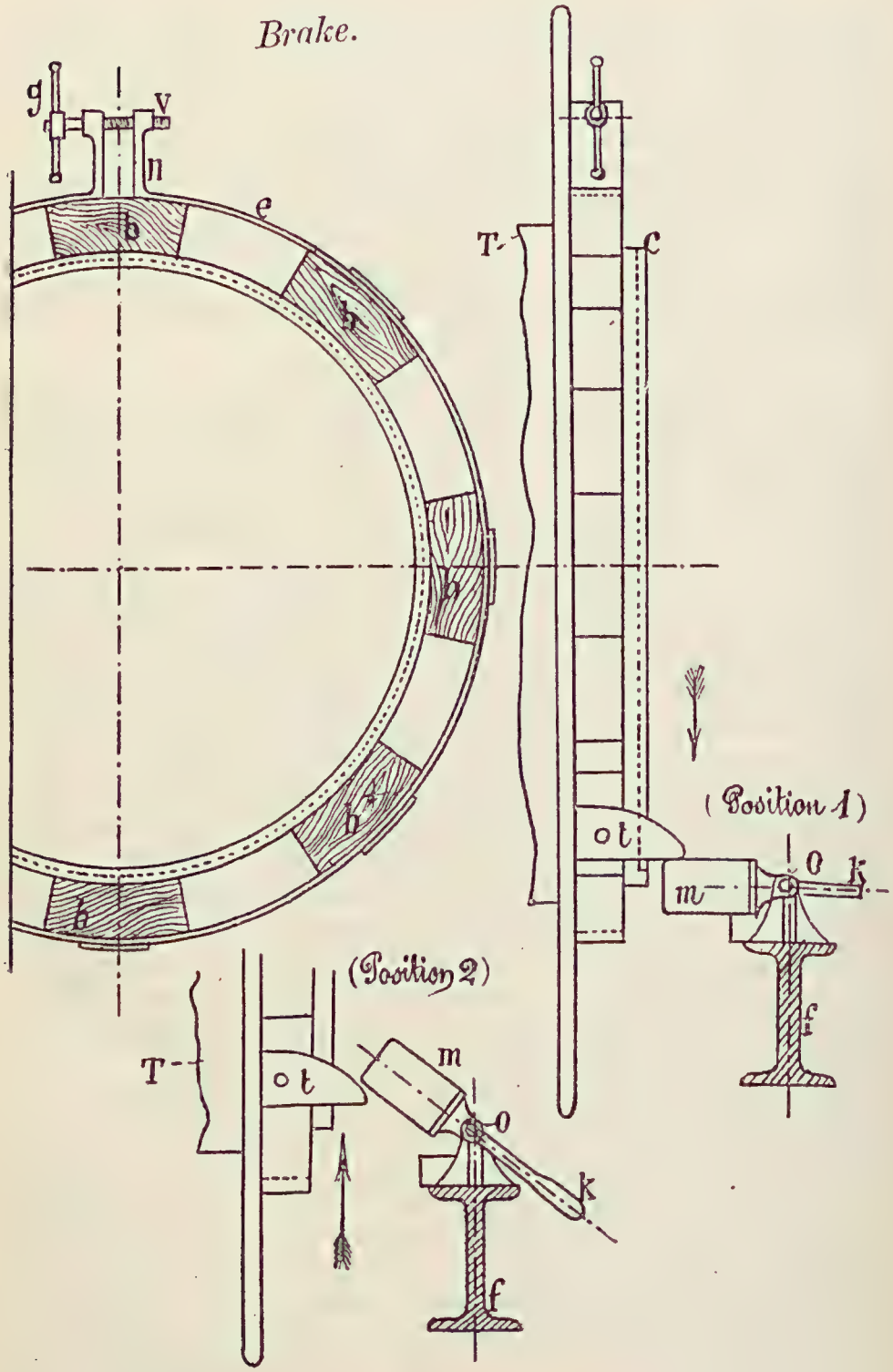


Fig. 79.—Diagram of Brake for Winding Drums

this is the main cause of the breakage of drum flanges and of the wear of the cable, the strands of which overlap each other, become tangled, and cause distortion, flattening, &c. In the machines designed for medium-sized properties, where the proprietor wishes to avoid complicated machinery, it is difficult to provide drums with winding guides (costly and cumbersome), such as those of Fowler and Howard; but it is always easy to attach that shown in Fig. 80, which costs very little to keep in repair, as the part subject to most wear is easily replaceable, and only costs 4s. 10d.

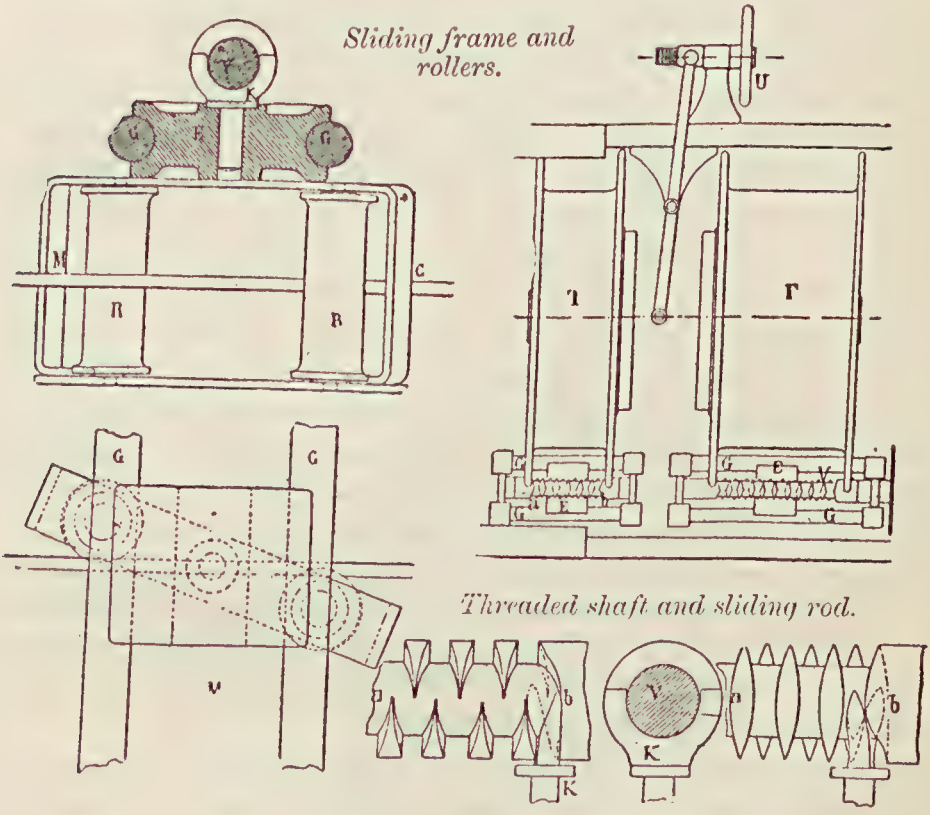


Fig. 80.—Winding Guide.

The principal part of the mechanism of this winding guide is a shaft V, round which two threads are cut in opposite directions, and opposite each drum, one winding to the right, the other to the left. Above the shaft, and parallel to it, are two cylindrical rods G serving as guides to a sliding frame M, carrying inside it two steel rollers RR and on the upper part the brass collar K. This collar revolves freely in a block E, through which the rods G pass, on which the block slides. Therefore it plays the part of a nut, and moves

in the direction of the thread on the shaft, guiding it, and with them the block E and the rollers RR, between which the cable C runs.

The space between the rollers RR, projected on a plane perpendicular to the cable, is exactly the diameter of the cable, but the space is greater in any other direction, so as to allow the free passage of any irregularity or splice in the cable preventing the rollers from being torn away.

The winding guide works as follows :—Let us assume the machine starting when the rod K is in *a*; this arm comes in contact with the thread of this shaft, and its speed is calculated so that the guide M travels at each turn of the drum a distance equal to the diameter of the cable. When the rod K reaches *b*, it is arrested by a block *b* on the threaded shaft V. The stop forces it to pivot round and engage the other thread. It then travels in the reverse direction, carrying the guide M; the rod then meets the stop *a*, pivots and returns, and so on until the winding of the cable is completed. The rod K is made of bronze, and wears out more rapidly than the steel screw, but is easily replaced.

The cable being the principal cause of the expense in steam ploughing it is necessary to take every precaution to diminish its wear, and, for this purpose, to support the cable on pulleys, so that it is only submitted to rolling friction. When the cable unwinds it is necessary to pass it over a pulley placed near the drum, as it has a tendency to come out of the groove on account of irregularities in the unwinding. A good method of keeping the cable in position consists in placing a small roller *r* in front of the pulley P, entering slightly into the groove (Fig. 82).

It is not sufficient to protect the cable against sliding friction on the frame of the drum ; it must also be protected against friction on the ground. This is prevented by cable runners. Most of the old systems used for cable supports were not practical ; they could only be kept in certain positions, and were very unsteady when the cable was being moved from furrow to furrow. The cable runner shown in Fig. 81 has proved satisfactory in practice. It is a small truck on three wheels, on which is a frame, carrying four rollers on top; two have a vertical axis, the two other rollers revolving horizontally ; and they are arranged in such a way that the juxtaposition of the groove of the four rollers forms a complete circle. The axle of the top roller can pivot round the spindle

A to allow the introduction of the cable *c*, which in any position slides on a roller. The axles of the three wheels are always parallel to the cable, which travels laterally with them.

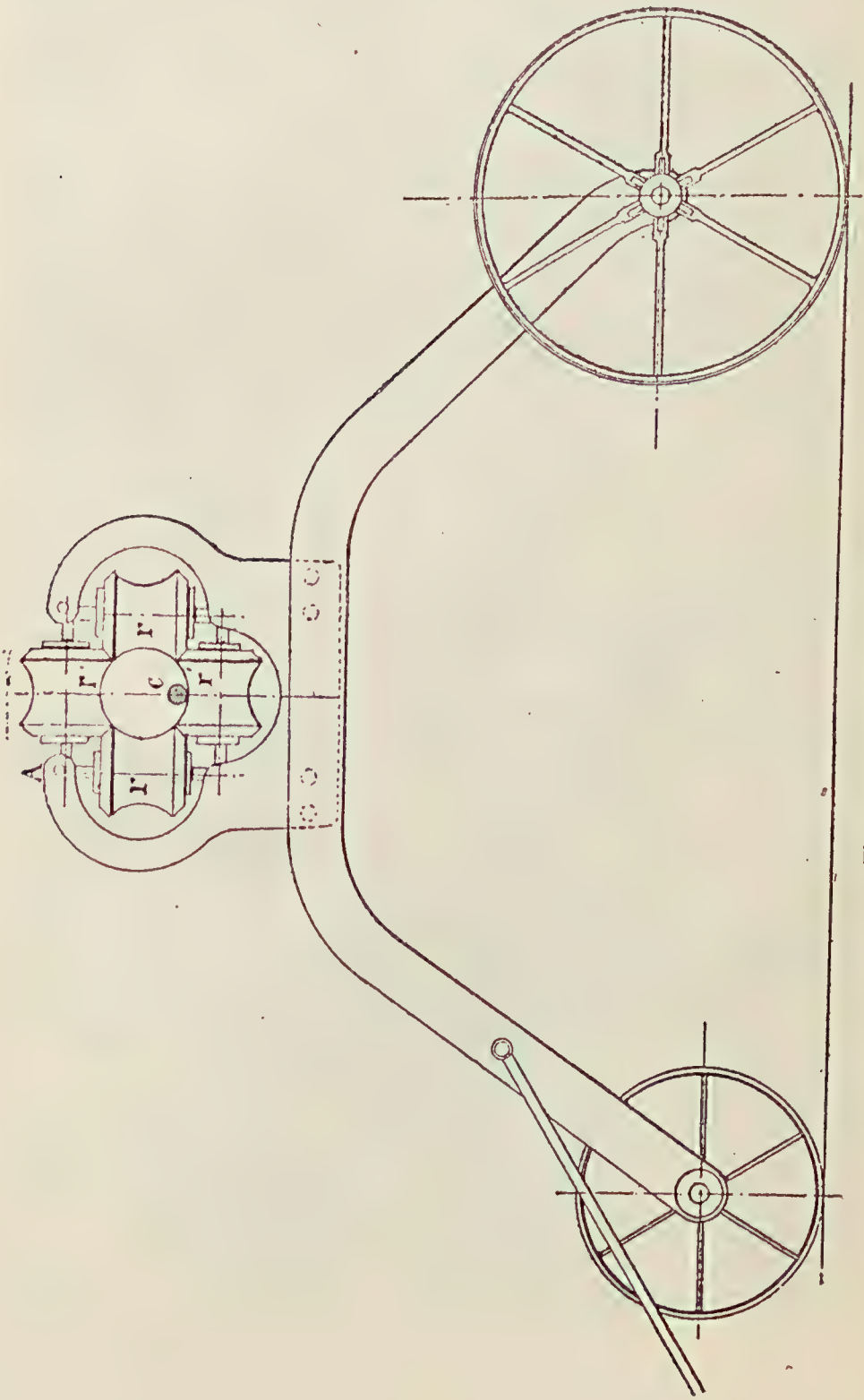


Fig. 81.—Cable Runner or Carrier.

We have already shown that a double-effect drum does the work per acre at less cost than a single-effect drum, the only troublesome point in the former being the anchoring of the fixed pulley. The steel anchors with two spikes give the best results, but they require to be strongly fixed, and many persons do not know how to manage them. We must not hesitate to place two or three behind each other joined by chains, if necessary. Moreover, if it rains during the night they must be pulled out and refixed. The anchors are completely sunk in the ground, and each of the spikes must be stayed by cross pegs *t t* (Fig. 82); the direction of the anchor must be carefully ascertained, as its position has great importance on their fixity. This is arrived at by an invariable rule; the line *m n* passing by the point of application of the pulley, must form equal angles α α, with the two parts of the cable passing over the pulley. The workmen find it by the following simple and practical method:—A rod 8 feet in length is taken, and one end placed in *i*, the point of intersection of the two parts of the cable; the distance the rod reaches in each direction is marked off, the two points joined by a rope and the point of the centre *o* determined. The direction *o i* is the direction sought. This method applies to any system of anchoring, for, when beams are used, they must be placed perpendicular to that line.

The fixed pulleys should be of large diameter, and fixed on wide plates. Fig. 82 represents a strong type of suitable dimensions. The pulley P is 33½ inches in diameter, and has a groove 2⅓ inches deep; it is thicker near the pivot, which is slightly conical, and has an average diameter of 2 1/10 inches. This pivot A traverses an iron plate *q r* slightly countersunk and inclined towards *q* and an oak plate 19½ inches wide, 3ft. 3in. long, 3 inches thick, strengthened on the side by two iron plates *f' f*, bolted through at *p p'*. The pivot A is held by a nut *e*, taking in at the same time a flat iron piece 2⅓ inches in width, *c c'*.

This piece *c c'* is bent and rounded at *c'* to a distance level with the top of the pivot; a piece *d* terminated by a hook fits on it; a pin keeps the piece *d* on the pivot A, another *g'* on the piece *c'*. This piece is indispensable to prevent the pivot A from bending under the traction of the cable.

The piece *d* may revolve round the pivot A to allow the cable to be taken out of the sheave. At the rear, a V-shaped

piece *k* is fixed over the piece *c'*. The chain of the anchor S is fastened to it. A block of wood 2 inches thick, fixed under and in front of B supports the pulley P, and prevents its axle from bending under the effort or traction, and at the same time protects the nut *e* when the pulley slides on the ground.

It is important to have several other simple tools on the spot—a spade, a pick, a sledge-hammer, a hammer, a spanner, and iron pegs—it is also necessary to have a lever to use, even in very wet soils, in order to dislodge the wheels or discs of the automatic anchors. The instrument shown (Fig. 82) answers this purpose. A wooden lever L, 8 feet in length, is terminated by an iron piece *a*, in the hole of which a double chain is fixed with hooks at each end; the lever can be raised or lowered between the branches of the piece B made of flat iron, bolted on a wide bed-plate S. The chain *c*

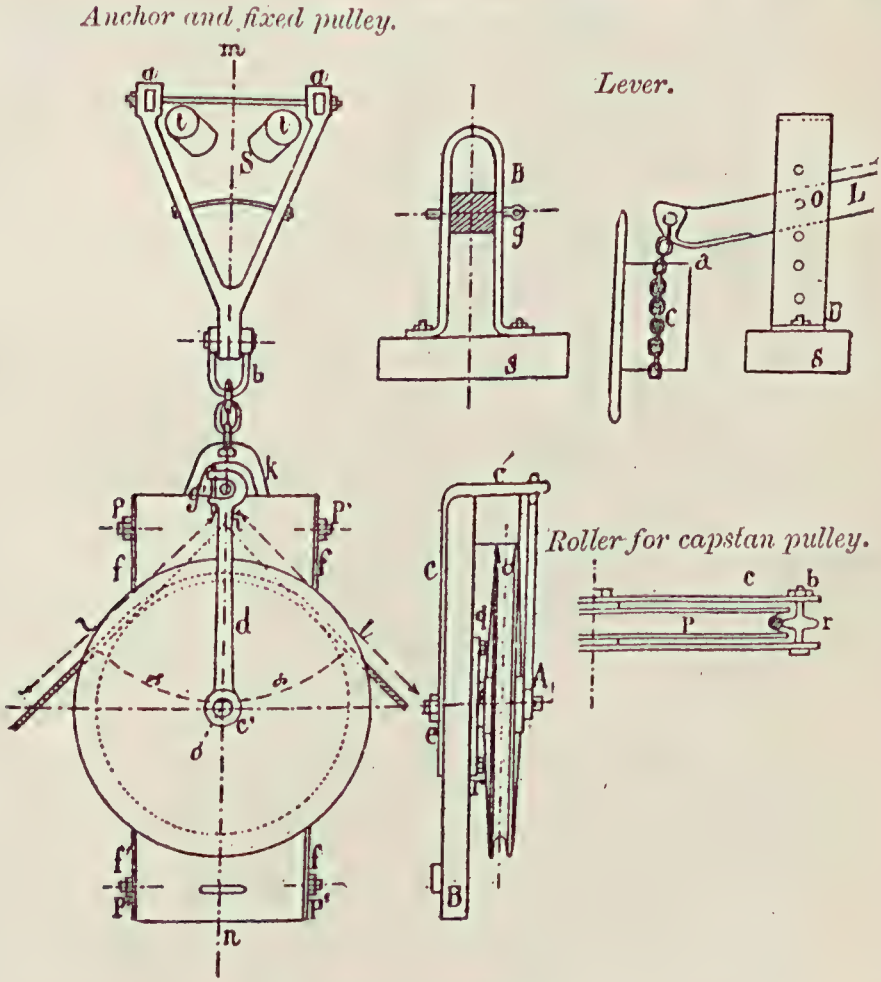


Fig. 82.—Accessories.

is fixed round the box of the wheel to be raised, and a man acting on the other end of the lever *k* may easily lift very heavy weights ; this instrument is more practicable than an ordinary screw-jack, which could not be used in very damp soils.

The most delicate and costly part of a subsoiling plant is the cable. Its strength and quality must be tested before purchasing it. The only cables used now are those made of steel wire, the diameter of which varies from $\frac{1}{2}$ inch to 0·86 inch. Above 0·86 inch they become too rigid, and do not wind easily around the drums. They are generally made of four strands, each of which is again divided into four strands twisted around a hemp cord. Each cable must be, when purchased, wound on *very strong* portable drums, for, if these drums break, it is very difficult and sometimes impossible to unwind the cable, which has, consequently, to be cut in many places, rendering it afterwards weaker. These cables must be very regular in diameter, supple, yet not extensible, for when they lengthen their diameter diminishes. They should resist an effort of 25,800 lbs. per square inch of section. When working normally their breaking strain should be 51,600 lbs. per square inch. In clay or clay-siliceous soils they are supposed to work 150 days of 10 hours with a steam-winding drum and a plough working at the rate of $15\frac{1}{2}$ inches per second ; and 450 days with a horse-winding drum and a plough working at the rate of 4 inches per second. The cables are guaranteed to work the above number of days, on the condition, however, that they are not made to support a strain greater than 25,800 lbs. per square inch of section, for above this effort of traction, which is the limit of elasticity of the cable, it will lengthen and dislocate. Notwithstanding every precaution, the cable may become entangled between the flanges of the drum and get broken. The two broken ends then have to be carefully spliced. This splicing requires great care and special tools, which should always be kept on the place—two well-tempered steel cold-chisels, a marline spike, made of a steel rod 0·6 to 0·8 inch in diameter, well sharpened at one end, and a strong hammer.

The two broken ends of the cable are cut with the cold-chisel (Fig. 83), the strands are unlayed for a length of 3ft. 10in., and fitted into each other. The ends are laced over and under the strands of the opposite rope, as shown in Fig. 83,

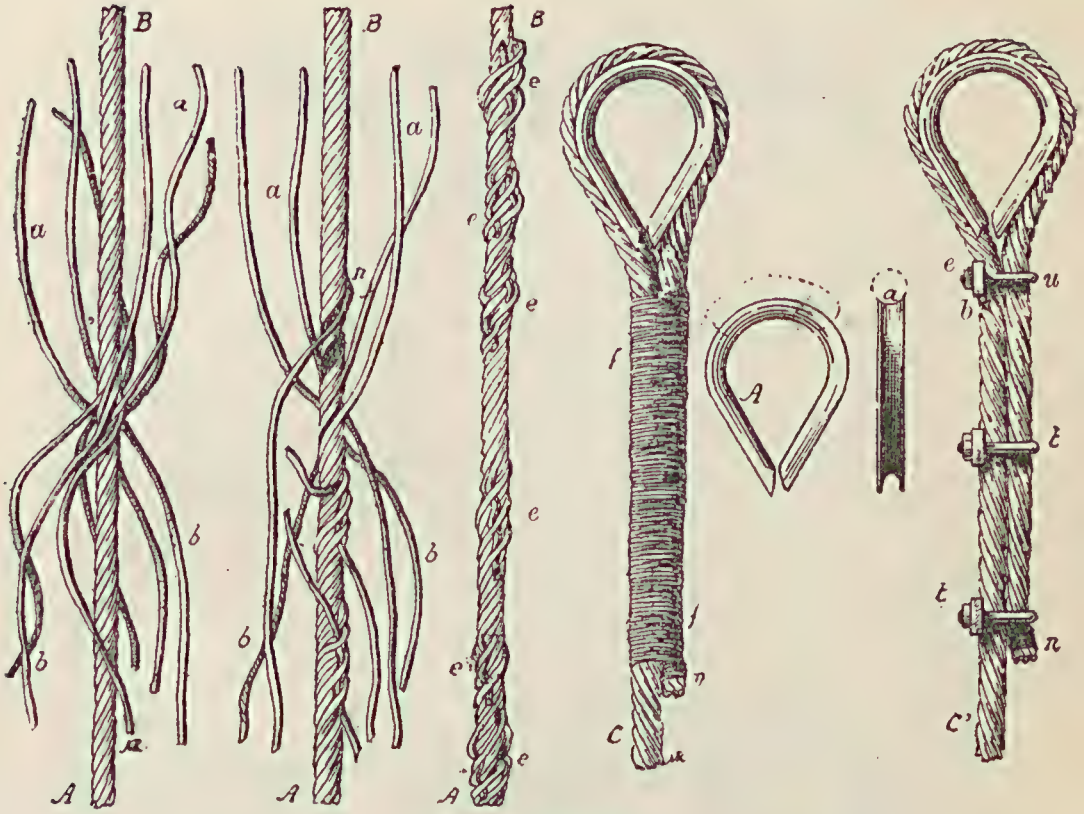


Fig. 83.—Splicing.

untwisting a little with the aid of a marline spike. The four ends must be left projecting 1 to 1½ inches ; if not, the splicing would not hold. When the splice passes over the drum for the first time, the rollers must be left a little wider, otherwise it might tear the cable ; this precaution is often overlooked, and is the cause of frequent accidents. The loose ends of the strands get flattened against the cable after the first winding.

We have insisted on these small details in working subsoiling plants, because all these precautions are indispensable, and it is almost always because viticulturists have neglected them, that they find some difficulty in working these machines, and are often stopped in the course of the work.

Many viticulturists wonder what can be done with these expensive machines after they have finished trenching work, as they often still remain in very good order. Those who possess these machines will find great advantage in utilizing them to perform the yearly ploughing of their vineyards, especially if the vines have been planted well apart (5 feet to 8 feet).

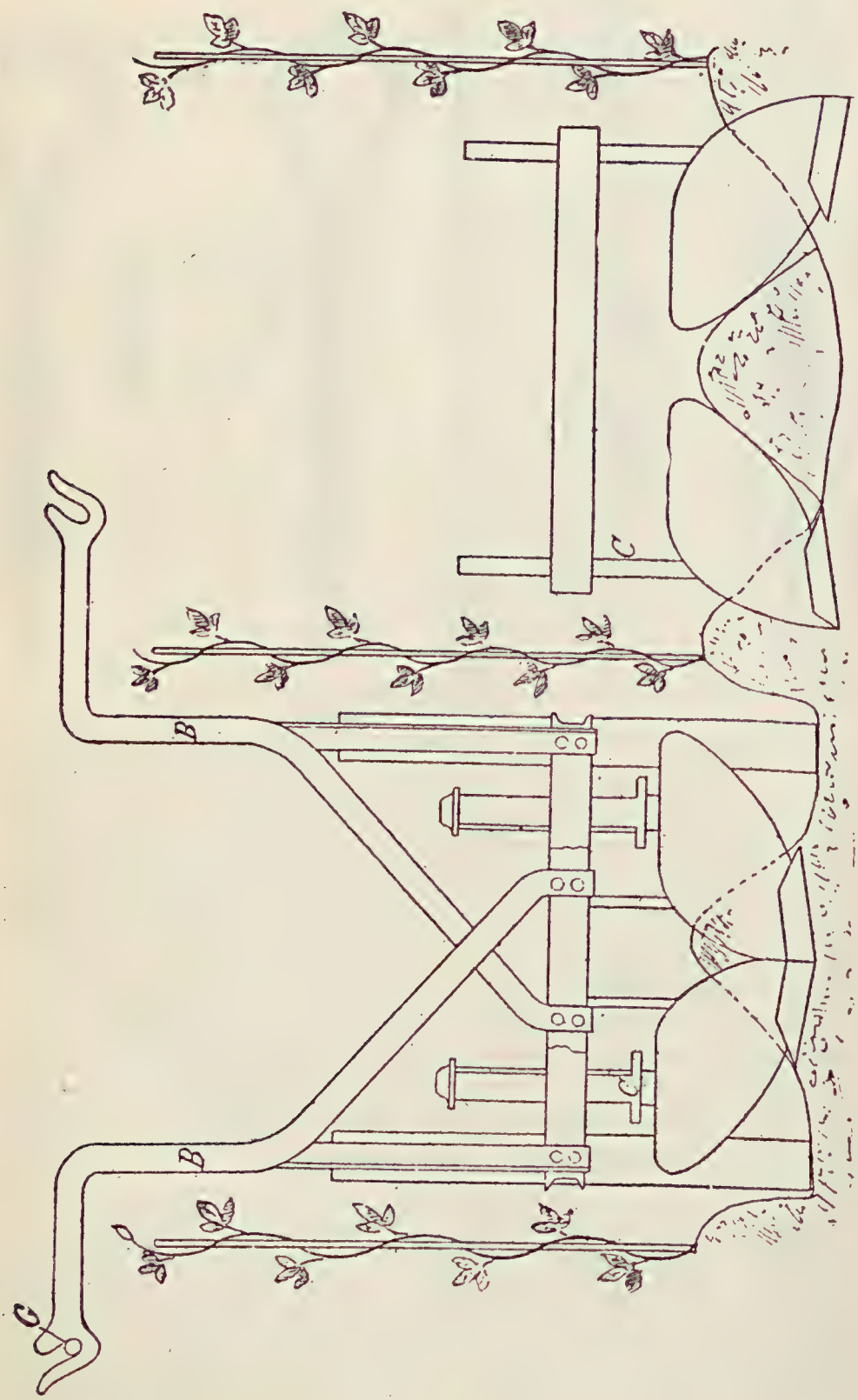


Fig. 84. – Bajac's Steam Plough for vineyard cultivation,

This is possible by using special ploughs, which are made after the fashion of steam-cultivators. These machines were invented and patented in France, and constructed in England by Fowler, and in France by Bajac. They are made of a very resistant iron frame, rounded at the rear, and narrowed between the wheels, strongly braced with double braces, between which the bodies of the implement are fixed.

The bodies of the plough may be fixed in four different positions lengthways ; the mould-boards may be so arranged as to throw the soil towards the centre or towards the outside (Fig. 84). During this work the vines must be protected against any friction from the cable which might pull down the stakes, or break the stumps. With this object, two arms B are fixed on the frame, and their width may vary so as to bring the cable on the outside of the next row of vines. The return cable is placed by the ploughman with the aid of a special mechanism at the end of the arm B, and, when the plough proceeds, it unwinds and places it between the next row of vines. With this system, the return cable becomes the traction cable ; when the plough has reached the end of the row, the cable is simply thrown on the ground, the plough pivoted round the wheel nearest the ploughed part, and started in a new row, in an opposite direction ; the other cable is lifted on the corresponding arm, and while the plough proceeds, it is placed between the next rows as in the first instance, ready for the return.

Many of these ploughs are working in Algeria, and are giving excellent results. They enable vignerons to plough between vines to a great depth, which has the advantage of allowing the water to reach the subsoil, thus keeping the soil moist during summer droughts.

With these machines, vine-growers will be able, not only to create and reconstitute vineyards, but also to use their winding-plant all the year round.

IV.

THE ADVANTAGES OF STEAM CULTIVATION.

By Prof. John Scott.*

The advantages resulting from the employment of steam-power in tillage operations are now generally recognised. One chief advantage is that it renders the farmer comparatively independent of labour; at all times he has an enormous power at his command on a moment's notice, and is thus able to deal with the land when in a fit state for cultivation. Another great advantage is that when the ordinary operations of breaking-up are done at the proper season, it will be found that no mechanical pulverization is required. The rapid motion of a steam-driven implement tears and breaks up the land so that it remains in a loose, rough state, and the atmosphere, acting upon the subsoil as well as on the upper part of the staple, permanently raises the temperature, pulverizes the whole by degrees, and thoroughly prepares it for the reception of the seed. All injurious treading by animals is avoided, and the roots of plants can easily penetrate to the subsoil.

In estimating the expense of steam cultivation few justly appreciate the great change that it effects in the character of the soil, both as regards the drainage and the cost of after tillage. When land has been once thoroughly broken up by steam, every succeeding operation requires less power; and the experience of those who have used steam-power proves that one-half only of the usual operations is required.

The value of steam tillage has been well exemplified from another point of view in droughty autumns. In very dry seasons, such as 1865, 1868, and 1870, after all harvest operations were concluded, the stubbles were so hard and dry that many farmers were compelled to wait for rain before they could be ploughed by horses, whereas, those who had the steam plough got to work at once, and had large breadths of land broken up and cleaned in the most efficient manner, the result of this thorough cleaning and tillage being most apparent in future crops.

There are now ploughing engines capable of exerting 100 indicated horse-power, and capable of putting a draught of 3 or 4 tons upon an implement at a rate varying between 3

* *Text Book on Farm Engineering*, 1885.

and 4 miles an hour. With such power any reasonable depth can be reached, and as the disintegrating power is, by a well-established mechanical law, as the square of the velocity, the soil is broken up with four times the mechanical effect at 4 miles an hour, as in the case of a horse-drawn plough at 2 miles an hour.

In the words of the carefully-considered report of the committee of the Royal Agricultural Society on steam cultivation (1867)—"A culture deeper than it is possible for horses to effect works a highly beneficial change in the texture of the soil, imparts additional efficiency to drainage works, augments the value of the manure applied, brings into operation certain latent properties of the soil which much increases its fertility; and it also fits land formerly unfit for the growth of turnips, allows of their being fed off by sheep, the operations of the field are economized, and the growth of all crops is stimulated."

"These are," says *Engineering*, "the remarks of a committee who had been labouring industriously for months in examining the results of steam cultivation upon nearly 200 steam-tilled farms in all parts of England and in some parts of Scotland, and are simply the deductions of the best experience. At the time of their report steam tillage was not only better but was considerably cheaper than horse tillage. Now, the steam-engine, rope, and other tackle and the attached implements have been very much improved, and the comparison would be still more in favour of steam. It would be something to save 2s. or 3s. per acre upon the 10,000,000 acres of tillage land in England yearly, and experience shows that this saving of £1,000,000 to £1,500,000 can certainly be accomplished. But the greatest gain is in the improved crops, due to thorough tillage, and this may amount to an extra quarter of wheat, an extra 3 or 4 tons of turnips, or something equivalent, and, in this way, the average crop may be increased possibly to the extent of £10,000,000. There are many recorded instances of steam-ploughed fields yielding 2 or more quarters of wheat per acre more than they did under horse tillage."

No doubt the cause of steam tillage has suffered from an indiscriminate use of deep ploughing in certain instances, but that has been a misapplication of the power.

On the other hand, in addition to ploughing and cultivating, great benefit is found to follow the application of steam

power to the drilling and harrowing in of seeds on heavy soils, especially in wet seasons, as the injurious effects of trampling by horses is therefore avoided.

Systems of Steam Cultivation.

Of the many schemes and systems of steam cultivation which have been practically brought before the public two only (and those the simplest) have proved themselves successful. In both of these the traction power is transmitted to the implement through a steel wire rope winding upon a drum. In the one plan the two winding drums are fixed in a windlass frame, and connected to a stationary steam-engine, which can be worked from one corner of a field. One end of each rope being made fast to the plough, the implement is drawn backwards and forwards by the drum pulling alternately, and the pulley, sheaves, and anchors at each end of the furrow move forward as the implement proceeds. In the other system, each of the winding drums is placed under the boiler of a self-moving steam-engine, and one engine at each end of the furrow alternately pulls the plough towards it, while the other moves forward into position ready for the return. These two systems are known as the single-engine or roundabout, and the double-engine or direct method of steam cultivation.

In noticing these two methods of working we shall take the double-engine system first. It must be understood, however, that any method of steam cultivation must needs involve considerable modification in detail to work equally advantageously under all circumstances. Under most other machinery a steam cultivating apparatus is required to work under greatly varying conditions, and often under circumstances where nothing whatever has been done to assist its introduction. The general formation, the condition and requirements of the country, the nature of the soil, the size and arrangement of the holdings, and the available capital, are all items which influence the application of steam-ploughing machinery, and may demand important modifications in its construction.

The Double-Engine System.

Fowler's direct method of working is illustrated in Fig. 85. It includes two self-moving engines with winding drums, 800 yards of steel rope, and the necessary implements. The

engines are worked on opposite head lands, and each alternately draws the implement towards itself, the engine not in work paying out the rope while moving forward into position for the return journey. Any kind of implement may be used.

The advantages of this double-engine system are — the short length of the rope required, and consequent economy of power, the facility with which the machine is set to work and taken up, and the small amount of wear and tear, due to the simplicity of the tackle. Its disadvantages are its first cost, and the difficulty of moving the engines on very soft or wet land. The last difficulty has been, however, almost entirely removed by increasing the diameter of the driving wheels.

For large farms and for letting for hire this system is the best, and has proved itself capable

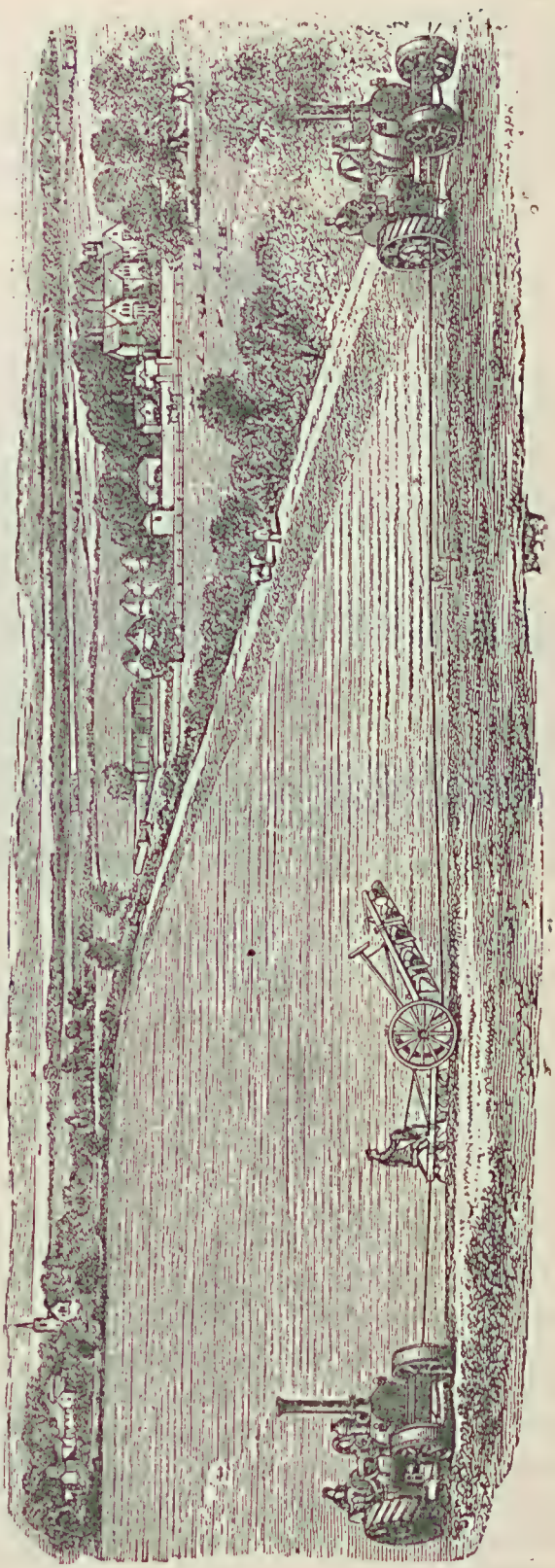


Fig. 85.—Fowler's Double-Engine System.

of doing more work per day at less cost than any other. Land can be ploughed by it at one-half the cost of horse-power.

Fig. 86 shows an engraving of Fowler's Single Cylinder Steam Ploughing Engine. These engines are made of 6, 10, 14, and 20 horse-power. They are constructed with single

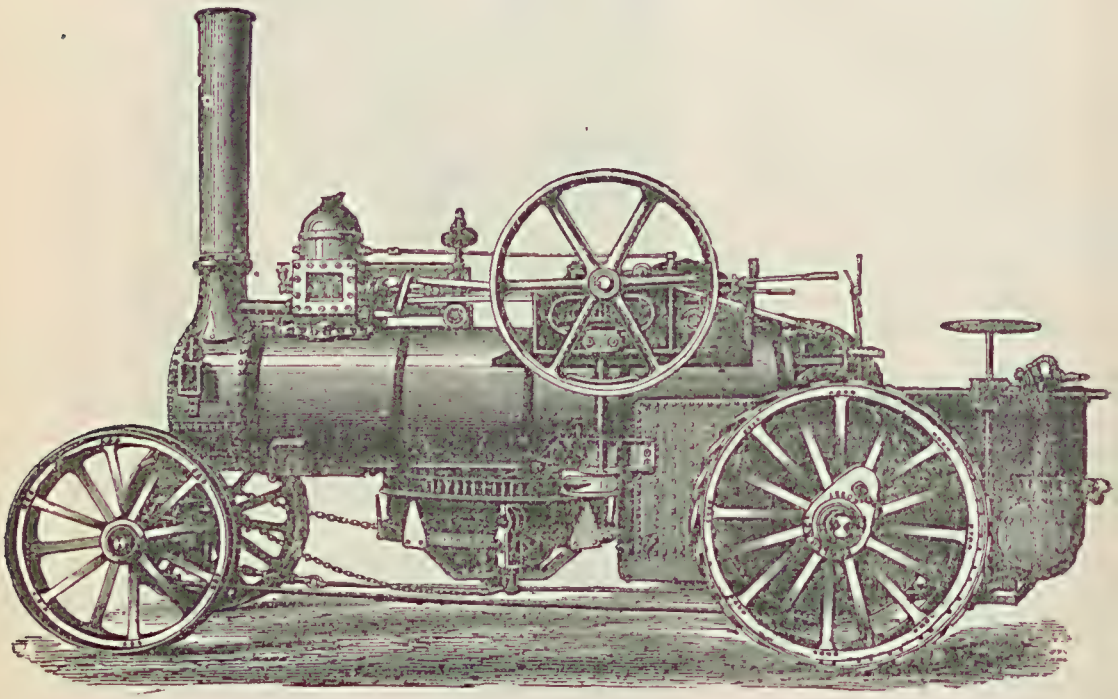


Fig. 86.—Fowler's Single Cylinder Steam Ploughing Engine.

steam-jacketed cylinders, and are provided with steam domes. The road-gear is constructed of spur-wheels, and made entirely of the best crucible steel. The road-wheels are wrought iron, from 16 to 24 inches wide. The engine has two travelling speeds, and is available as a traction-engine, and can be used for any agricultural purpose, such as threshing, pumping, grinding, sawing, or any operation of the kind. The power is conveyed to the winding drum by an upright shaft from the crank shaft. The winding apparatus consists of a horizontal drum, which, by means of coiling gear, winds and unwinds the wire rope uniformly without any attention from the man in charge. This is done by a self-acting lever, which carries two vertical guide pulleys, moving slowly up and down, and freely swinging round the drum into any position at which the rope has to work. By this means all strain on the rope, as well as on the apparatus, is avoided.

The Improved Single-engine System.

Howard's steam-ploughing machinery on the single-engine system is shown at work in Fig. 87. This is an improvement on the old single-engine or roundabout system, as the

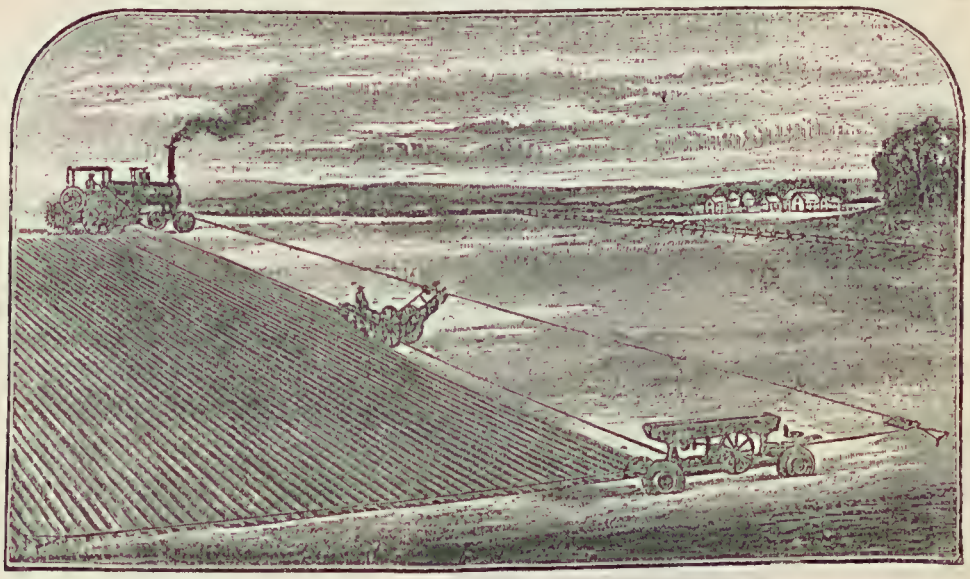


Fig. 87.—Single-engine System.

engine here employed (Howard's "Farmer's Engine" for ploughing on the single-engine system) is not stationary, but moves itself along one headland. The automatic anchor, which is remarkably simple and effective, moves along the opposite headland at each bout as the work proceeds. In this way much less time and labour are required to start work in the field than with any other single-engine system, and a shorter length of rope is used. Only two men, the engine-driver and the ploughman, with a lad for the rope porters, are employed.

The advantages of the single-engine system are in the comparative cheapness of the tackle, and in its superior fitness for very hilly or awkwardly shaped fields, as it can then be worked on the stationary or roundabout method with two automatic anchors. Its disadvantages consist in loss of power, great length of wire rope, wasteful expenditure of time in removals, and great quantity of apparatus necessary.

Implements used in Steam Cultivation.

The implements used in steam cultivation are all made on one of three principles :—

1. Balance implements.
2. Turning implements.
3. Implements which go backward and forward without either turning or lifting.

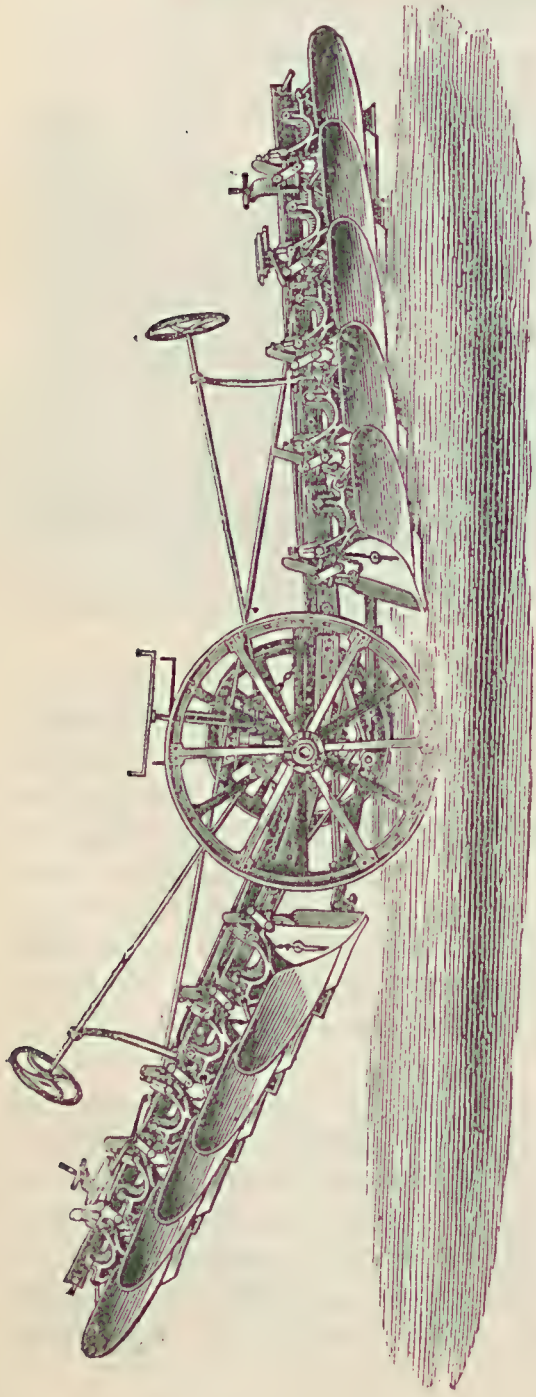


Fig. 88.—Balance Plough.

Balance Plough.

Fig. 88 represents Fowler's Patent Balance Plough, made for two to eight furrows, as circumstances may require, the construction of which has been considerably improved by the patented invention of the simple plan of always obtaining an adjustable width of furrow. The rigid iron frame, which is so essentially necessary to all steam-driven implements, is still maintained, and the alteration of the width of the furrows is effected by means of a wedge, which throws the ploughs at different angles to the frame. This wedge does away entirely with bolts and screws, and renders the position of the ploughs thoroughly rigid, at the same time is the best means of altering the width of the furrows. Several operations can be performed by this implement without much alteration.

The frame is so arranged that the shape of the ploughs and mould-boards can be varied to suit any circumstances that the land may require. Any class of mould-board can be supplied. By removing the ordinary mould-board used for surface ploughing, and substituting short ones, or "digging breasts," a tillage can be effected quite equal, if not superior, to spade husbandry, which leaves the land in the most desirable state for the action of the atmosphere. From the shares and mould-boards being attached on the outside of the beam all choking in very foul land is obviated.

In ploughing lea or other land for cereal crops, from the speed of the plough, the work done is sometimes rough and rather too loose, unless a land-presser or consolidator is attached to and drawn behind the plough. It is necessary to have the presser one furrow larger than the plough; by the use of the presser a firm seed-bed is secured.

Subsoil Plough.

This implement (Fig. 89) is constructed by J. Fowler and Co., and worked on the principle of a balance plough.

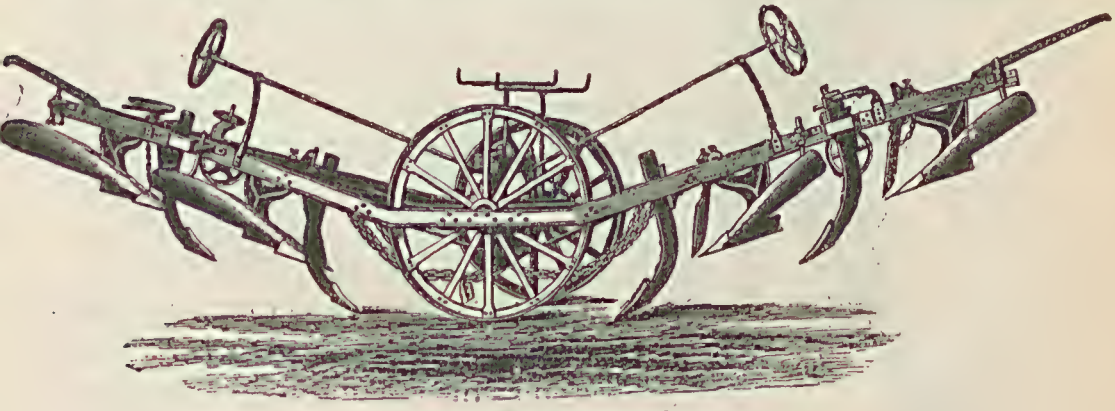


Fig. 89.—Subsoil Plough.

Besides the ordinary ploughs attached to it, it is fitted with tines, one tine following each plough and breaking up the subsoil to any required depth without throwing it on the top of the land. In some land it is simply ruinous to bring the subsoil at once to the surface. But by admitting the atmosphere it may be gradually prepared for this operation.

Sutherland Reclamation Plough.

This (Fig. 90) is also an implement invented by Fowler and Co., and has been much used by them in carrying out the Sutherland Reclamation works. It is so constructed

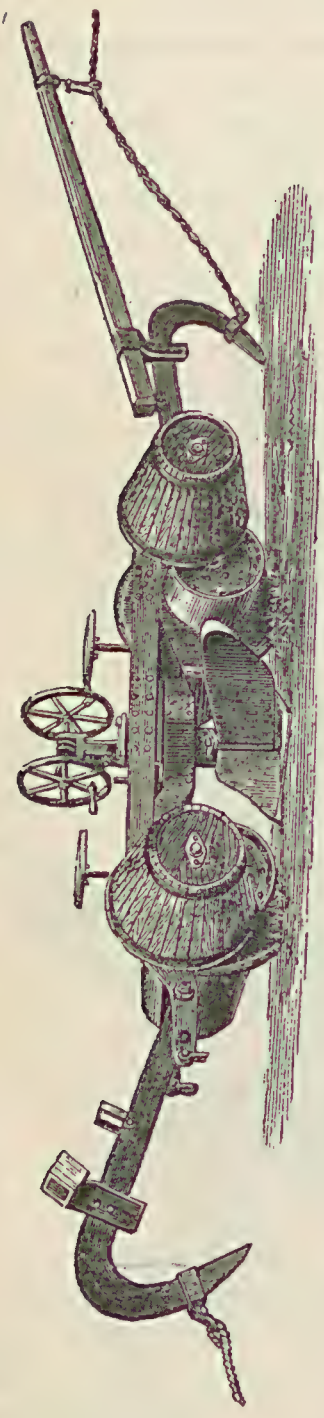


Fig. 90.—Sutherland Reclamation Plough.

that the most stony land can be cultivated without trouble or breakage. It will be seen from the engraving that it is preceded by steel discs, which lift the plough over the stones or obstructions so as not to break the mould-board. The plough will turn a furrow 2 feet wide by 15 inches deep completely over, and it will be observed that the turning of the furrow slice is not altogether effected by the mould-board, but is very materially assisted by the rollers, which catch it at the moment of leaving the plough. The stones which have been passed over are caught by the hook-tine, which comes behind the plough, and torn out. They are then removed by men. The tine thoroughly subsoils the land to a depth of 2 feet, and materially assists the drainage of the soil. This implement has been largely used for the last three years in the reclamation of land in Sutherland.

Turning Cultivator.

Fowler's Patent Turning Cultivator (Fig. 91) is adapted by all systems of steam-cultivating machinery. It consists of a strong iron frame, carrying, according to circumstances, from five to thirteen tines, and resting on three road-wheels, the front wheel being flanged and used for steering. The axle of the two hind wheels is cranked, so that by turning it the frame is lowered or raised, and the depth of the tines adjusted. The long end of the draft bar or "patent turning lever" is provided with two arms, to which the two ends of the ropes are attached. The arms are set at an angle to keep the tail rope clear of the implement. The lever itself

is held by a vertical stud fixed to the frame considerably behind the steering wheel. This position of the draft stud (the subject of a special patent) gives the necessary liberty

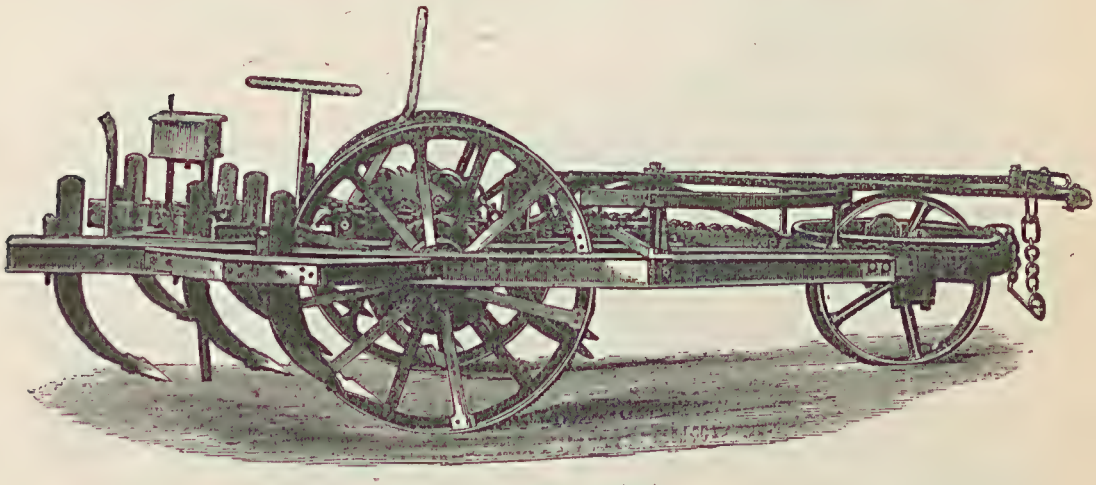


Fig. 91.—Turning Cultivator.

and power to the steering wheel, and enables it to lead the implement at almost any angle out of the line of the pulling rope. On the short end of the turning lever is a chain communicating with a quadrant on the crank axle, and as the lever is pulled round the chain acting on the quadrant turns the axle, lifts the frame, and raises the tines out of the ground. The plan of operation is as follows :—As soon as the cultivator is brought up to the headland the reverse pull brings the lever round and lifts the tines out of the ground, and they are held up by a catch ; when lifted the required height the lever strikes against a stop, and the implement turns into new ground ; the man (who never leaves his seat) releases the catch, the tines drop into the ground, and the implement is drawn across the field.

The principal advantages of this implement are as follows :—Its size is only limited by the power of the engines, which thus may be used to their utmost capacity. It smashes up the soil, working steadily, and always preserving a perfectly uniform depth. Even the largest implements of this description require only one man in attendance. In rounding round no additional work is required, and scarcely any time is lost, whilst the implement, however wide, at once moves into new land, leaving small and irregular headlands. On average soil 30 to 50 acres per day may be efficiently cultivated. Ridging bodies attached to the frame of the cultivator make an effective and easily handled ridging implement.

The ridging bodies are attached without taking away the tines, and both operations are done at the same time.

This implement is well suited for the last operation in autumn, as it effectually exposes the soil to the action of the atmosphere.

Grubber or Knifer.

This instrument (Fig. 92) is also one of Fowler's, and is extremely valuable on stiff clay land. By working it 2 feet deep, the subsoil can be stirred and aerated without at all

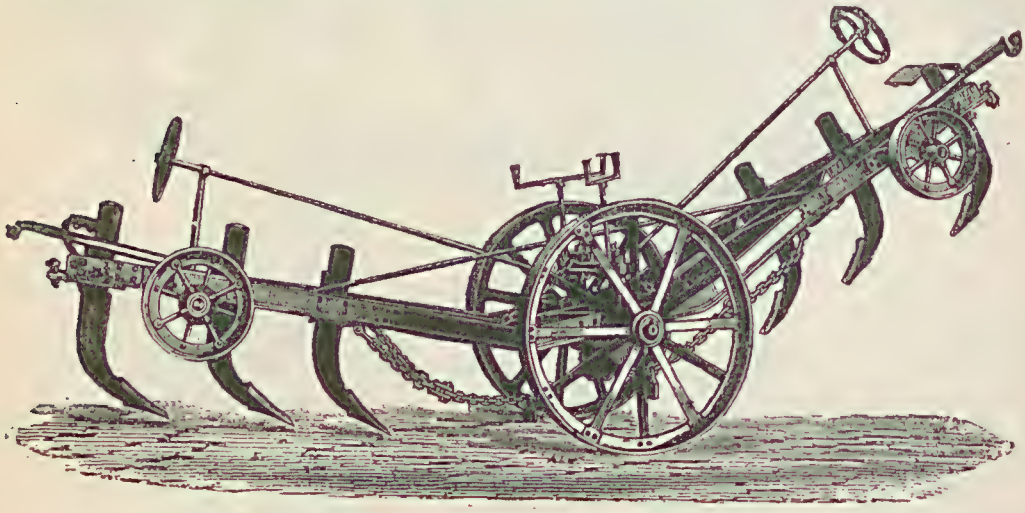


Fig. 92.—Grubber or Knifer.

interfering with the surface. The benefits which result from this operation are of the utmost importance. By its use the land is quite altered in its nature, and the advantage to the crops has been of very marked description. The drainage is also greatly assisted, and we wish to call the special attention of occupiers of clay land to this implement. It is made with one, two, or three tines.

It is also adapted for removing tree roots or stones, and can be worked 3 feet deep.

This is an excellent implement for stirring up the subsoil of old grass land, and to all owners of clay land is a decided advantage.

Turning Harrow.

Fowler's Patent Turning Harrow for steam cultivation is shown in Fig. 93. The difficulty occasioned by the ordinary cultivator turning up more callous stuff than is desirable in the spring of the year is entirely obviated by the use of this implement, which, it will be seen, is a combination of cultivator

and harrow, and is adapted for doing work which may be described as half-way between that effected by a cultivator and harrow, and superior to any horse cultivation.

Two kinds of shares are made for this implement—one a board share for cutting the whole ground, the other a square-pointed share for moving the soil only; but the requirements of the farmer will always determine which of these should be used. As a matter of economy, it is advisable to keep a complete set of tines and points of each kind always in stock.

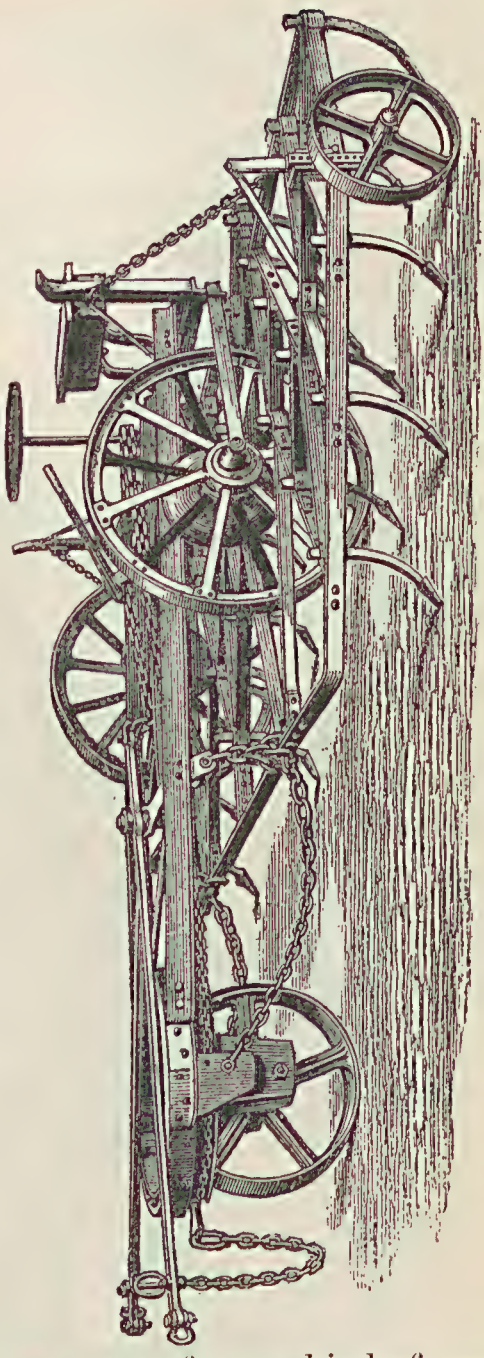


Fig. 93.—Turning Harrow.

This implement is constructed in three pieces so as to accommodate itself to uneven surfaces, and will take a breadth of 10 to 15 feet; it is especially designed to work on land that has been steam-ploughed, dug, or cultivated in the previous autumn, and it will do everything necessary in the spring to insure the land being in a proper state for any kind of crop. The steering frame is so arranged that it will take different harrows, from the lightest seed-harrow up to regular light cultivating tools; it also can be fitted with light ridging ploughs. In a similar way to the action of the cultivator previously described it is lifted at the end and turned round, thus getting into new work at once.

Three ridging bodies can be put on the steering frame by removing the harrow frame.

This exceedingly useful implement is made of wrought iron, with welded sockets for the tine.

A light harrow or any such implement can be hung behind it if desired.

Howard's Steam Harrows.

These harrows (Fig. 94) are very suitable for pulverizing and cleaning land after it has been broken up by the steam

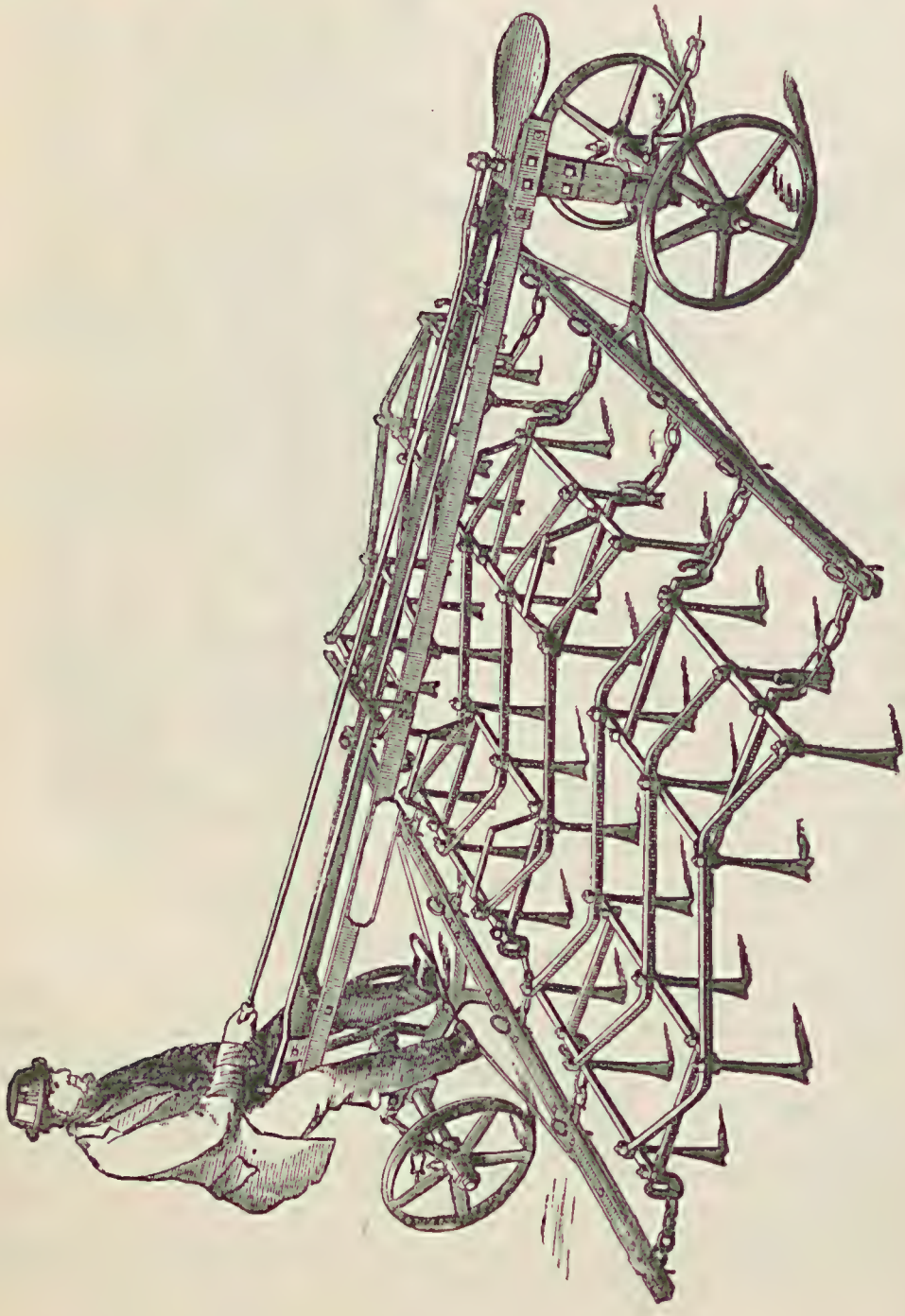


Fig. 94.—Howard's Steam Harrows.

cultivator. With "The Farmer's Engine," or the roundabout system, 15 to 20 acres may be harrowed in a day. The tines of the harrows, which are fitted with double-ended rocking-points, and which can be easily renewed when necessary, are made for drawing out the couch-grass or twitch without breaking it, so that it can be collected and burnt.

Fowler's Patent Discer.

This instrument is intended to cultivate newly reclaimed soil without tearing up the solid furrow and bringing the turfy matter to the top. It does this most effectively, merely pulverizing the top to a depth of 3 to 4 inches, and it leaves the turf at the bottom to rot, and considerably reduces the expense of pulverization for a crop. In moss and grass land this implement is invaluable, and it may be used with advantage in ordinary cultivation. It was first used in the Sutherland reclamations in 1876.

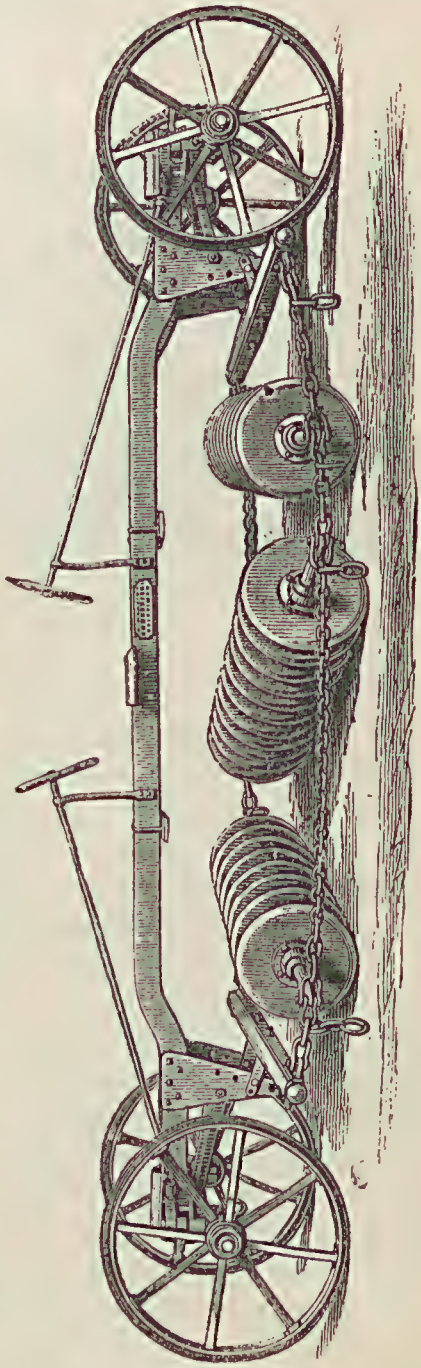


Fig. 95.—Fowler's Patent Discer.

The Discer (Fig. 95) has three axles, set askew to each other and to the line of draught, each of them carrying a number of thin discs, which revolve freely as the machine is drawn forward, cut the turf or peat to a few inches in depth, and throw the disintegrated mould into little furrows.

Steam Roller.

Fowler's Steam Roller, shown in Fig. 96, is made a total width of 15 feet, and may be fitted with any description of

roller, or with roller and harrows. The frame is hinged in the middle, and can be readily taken to pieces, so that, in moving from field to field, the two halves are pulled one behind the other, any difficulty in moving this broad implement about being thus effectually overcome.

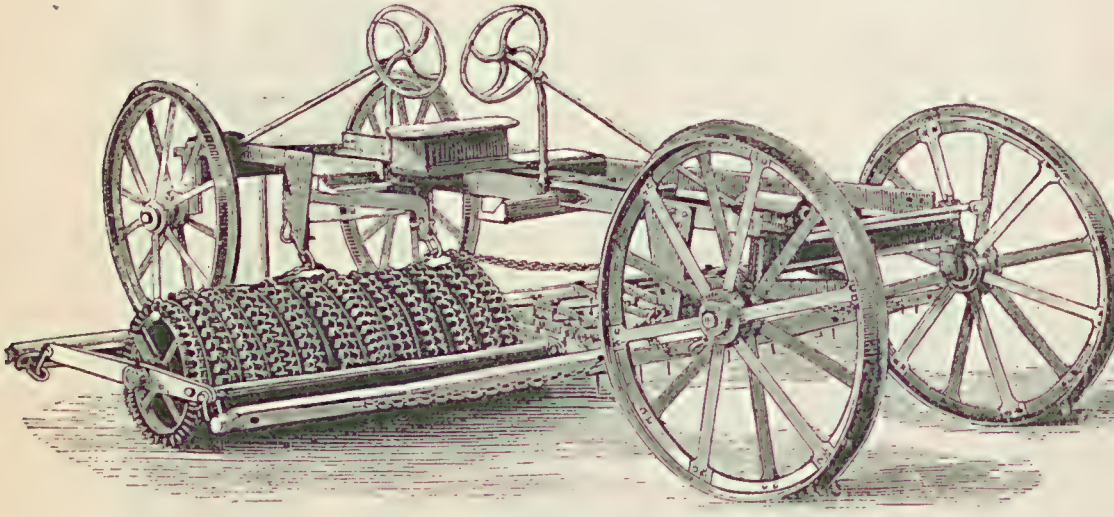


Fig. 96.—Steam Roller and Harrow.

Combined Steam Drill and Harrow.

The great drawback to steam drilling has been that even a drill of the largest width admissible under ordinary circumstances requires only a fraction of the power which is at the disposal of the engines generally supplied for cultivating operations. Only by combining other operations, such as light cultivating and harrowing with drilling, can the power be advantageously applied.

For this reason the steam drill is combined with a light cultivator or heavy harrow in front of the seed-coulter, and a light seed harrow following the same. Thus, three distinct operations are performed in going over the land once.

Fowler's Steam Drill has a total width of 9 feet. In turning round, the heavy harrows are lifted by the power of the engine, and the whole implement moves at once on new ground, the same mechanical principles being applied as in the turning cultivator previously described.

The advantages of this combination are very great, for when the land is prepared, 30 acres and upwards a day are efficiently drilled and harrowed without the trampling of the seed-bed with the horses' feet.

V.

PORTABLE WIND MOTORS APPLIED TO TRENCHING AND SUBSOILING.*

By M. Charvet.

Wind.

Wind is the more or less rapid movement of translation communicated to different parts of the atmosphere. It is generally assumed that this phenomenon is due to the variations in density of different masses of air under the influence of heat or cold. The air of cool regions travels towards warmer regions, hence those huge currents, some of which are constant and periodical, *trade winds;* and others, variable, such as those often observed inland.

The configuration of the country has a powerful influence on the direction of the winds, at least for the lower strata, which alone are utilized by the wind motors in actual use. Mountain ranges, forests, river valleys, break atmospheric currents, and deflect the direction they would follow under the action of the causes which produced them, distributing them in all directions. Therefore, the study of wind currents is a very complex question, when it applies to a large tract of country. If, on the contrary, it is restricted to a small locality it becomes simpler, and may in many cases furnish useful indications for the construction and establishment of wind motors. In a certain spot, every year, at the same time, the winds will recur with the same speed and the same direction, as the obstacles deflecting them remain, and that the causes producing them recur periodically with the seasons.

It is in this state of variations that agricultural industries must take the wind to utilize it as a motive power. The mechanical arrangements of the motors should be suited to the variations, not only of direction, but also of intensity. As the causes disturbing the equilibrium of atmospherical columns are essentially variable, it naturally follows that the effect, that is to say the rate of speed of the air producing the motive power, is also variable.

The regions where these motors will be used with the greatest advantage are plains, or summits in hilly countries, sometimes even in certain positions at the entrance or exit

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* *Le Progrès Agricole et Viticole.* Vol. 17, 1892.

of a valley. There the winds follow their natural movement without encountering any obstacles ; or the configuration of the surrounding country may be such as to send many winds from different points of the compass in one direction; this should be chosen to install a motor. The Mediterranean region is favoured as much as the plains of Holland as far as the constancy and frequence of wind are concerned, and the results of meteorological observation, which will be given subsequently, allow us to estimate the number of days such a motor may be worked.

The natural forces, such as water or wind, are gratuitous forces, as is often remarked. These forces, it is true, do not cost anything, but they must be mastered and transformed, and the motor used for their transformation and application of it to a certain class of work represents a certain amount of capital which must be written off ; the presence of a man is also necessary for the supervision of the machine. That is why wind, of all motive power, is generally the last to which recourse is had, for industrial or agricultural operations, for it is too capricious ; but we must acknowledge that such a motive power presents economic advantages, for the power is spread naturally over a great area. On a large plain the number of the points upon which that force may be rendered available is considerable.

If it is preferable to utilize a water-course whenever the opportunity exists, on account of the great regularity, it is nevertheless true that a wind motor has the advantage of being erectable in any point of the region and more so in large plains, generally deficient in water, where the wind blows with great force ; and Lucet's motor has the advantage of being very portable.

This could not apply to the use of water as a motive power, but water can be carried to the motor, its force adjusted so as to obtain regular work. In the case of wind this, however, does not apply. We must take it as it comes, both in force and direction.

Utilization of the Motive Power of Wind.

In all mechanical operations requiring constant and regular motive power, all those consisting of a series of operations dependent on one another, and to which much manual labour has to be applied, wind cannot be used. It can only serve for operations requiring little manual labour, in which the

power and the rate may increase or diminish, or even stop, without inconvenience. Such are tanning, oil, flour, and sawing mills, and, above all, irrigation, draining, and trenching—this we intend to study.

Different Systems of Wind Motors.

Windmills, the origin of which is very remote according to historians, who trace them back to Oriental nations, were much more used for all kinds of operations formerly than nowadays. The facility of transit and competition with steam-power have reduced their use to instances where they are really economical. Finally, their immovable nature and great size, when a certain power has to be obtained, prevent their use for farm works other than those for which they are specially erected. It is to be assumed that the portability of Lucet's motor will satisfy many requirements.

Wind motors may be divided into three classes :—

1. *Motors with horizontal or slightly inclined axis:*
   Ordinary windmills, with slightly concave blades ;
   Dutch windmills, with plane blades ;
   Berthon, Durand, Bellon windmills ;
   American windmills, with plane blades ;
   Lucet's motor, with parabolic blades.
2. *Motors with vertical axis:*
   Robinson's Windmill ;
   Panemones, &c.
3. *Atmospheric turbines.*

The description of the principal types of wind motors may be found in almost all works on industrial or agricultural engineering ; it is therefore easy to choose amongst them that which will apply best to the class of work required. Therefore, we will only study Lucet's motor, which is actually in use at the inventor's property at Conques, near Carcassonne. Its novel arrangements and restricted dimensions for so strong a motive power deserve special attention.

Lucet's Motor.

The motor requires no foundation or anchoring, for it is portable. It could even be called a locomotive if its rate of travelling allowed such a comparison to be made. It is astonishing to see this machine, heavy enough to resist the traction of the plough, hauling itself on its cable simply by the action of the wind, travelling slowly but surely over ploughed land, roads, or bridges.

Truck.—The truck is made of four large oak beams of 12 × 12 inches section, AA′ and BB′, mortised together so as to form a frame 13ft. 9in. × 18 feet. This frame rests on two strong girders CC′ made of ashwood, under which iron axles, 11 feet long, $2\frac{3}{4} \times 2\frac{3}{4}$ inches section, are bolted. Four cast-iron wheels DD′, 20 inches in diameter, are

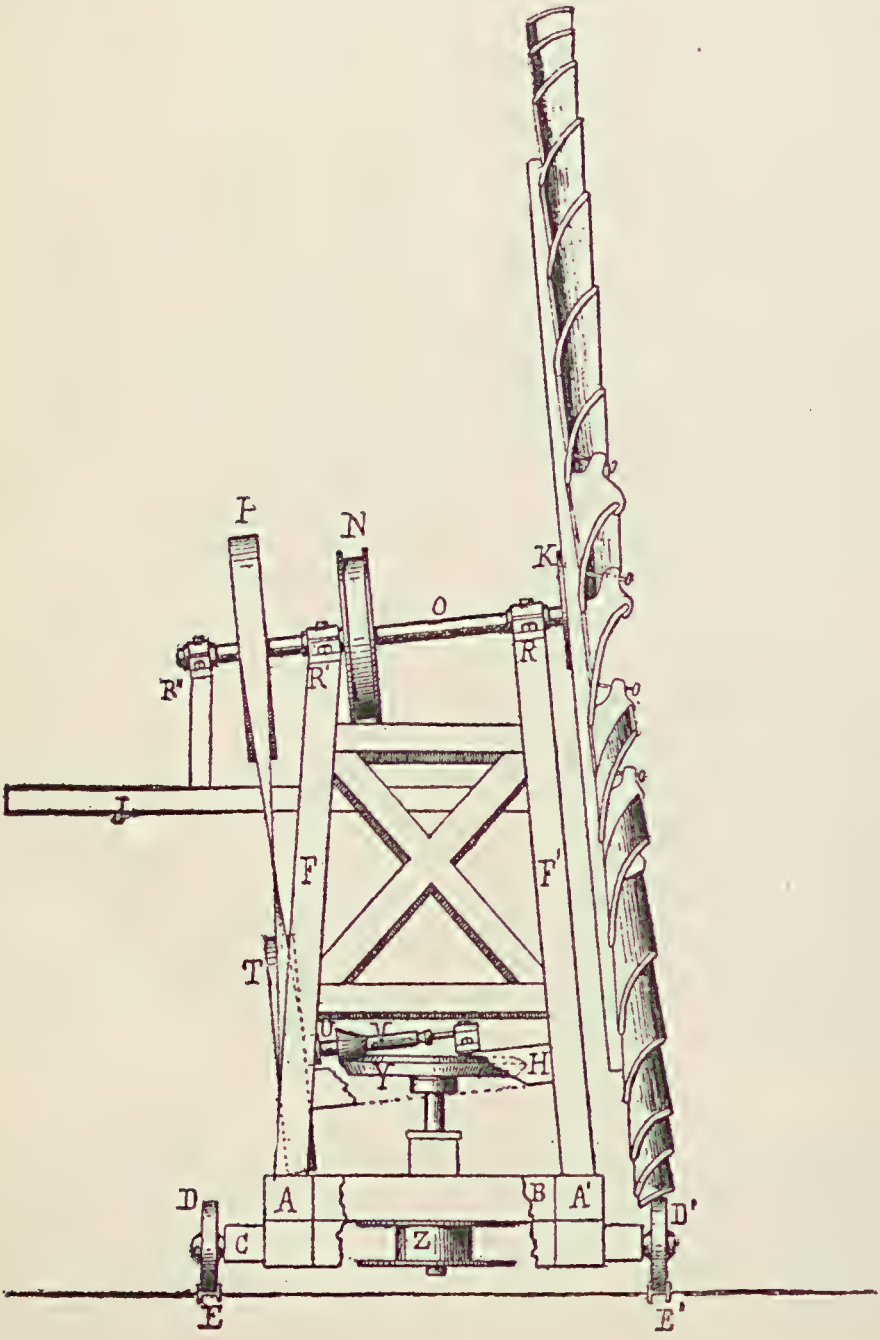

Fig. 97.—Lucet's Motor. Side Elevation.

attached to the axles, which are fixed in such a way that the four points of support (that is to say, where the wheels touch the ground) form a rectangle of 9ft. 10in. × 14 feet. The wheels are made so that their wide rim exactly fits between the flanges of rolled joist girders ($5\frac{1}{2}$ inches) EE′ (Fig. 97). Each of these girders weighs 220 lbs. They are, therefore, easily managed by two men.

Framework.—A rolled joist girder Q, 21 inches wide, is fixed under the centre of the truck; the shaft of the winding drum revolves in its centre. Four oak beams, 8 × 8 inches section F F′ and G G′, are mortised on the frame on a bevel, each pair joining at the top, and being each mortised

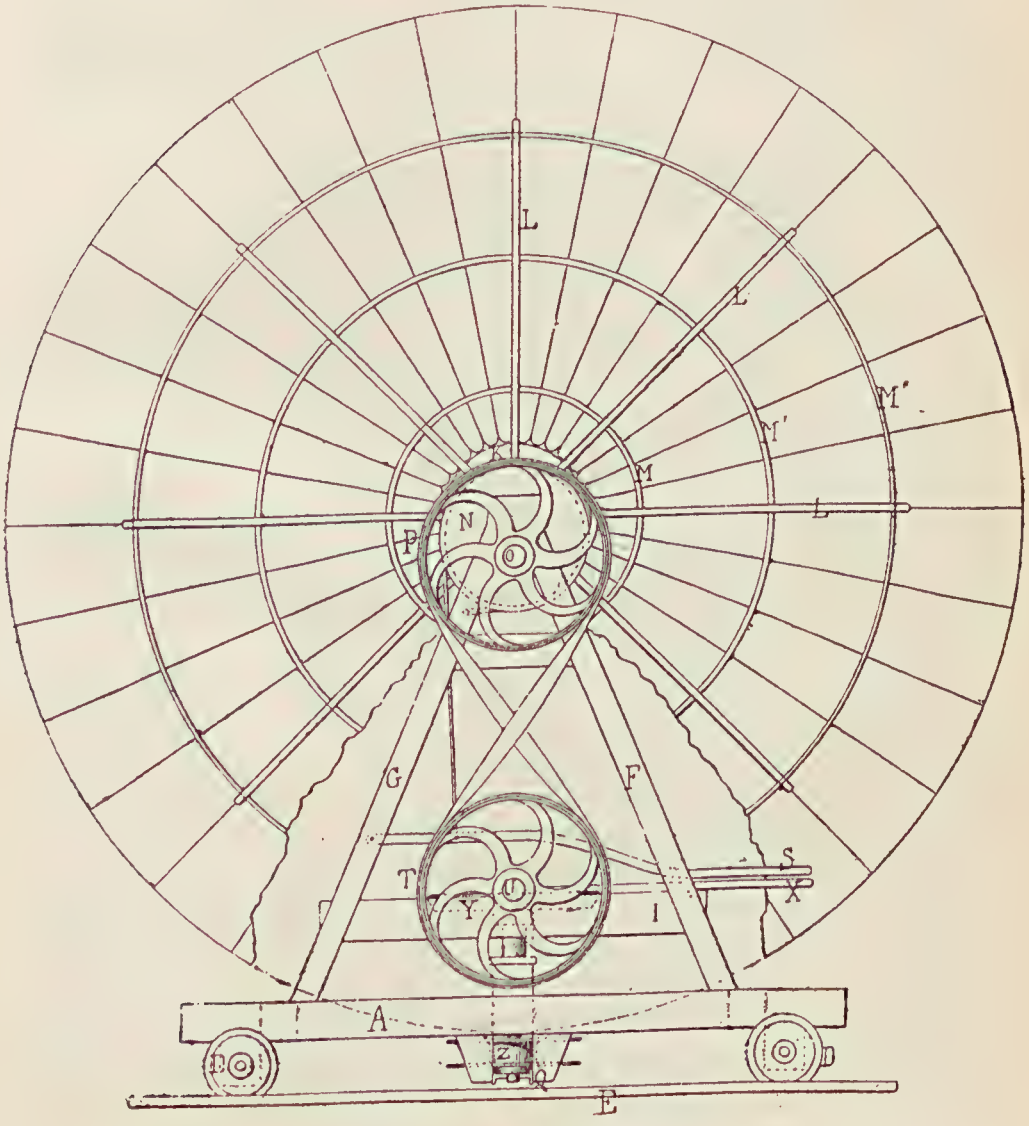

Fig. 98.—Lucet's Motor. Front Elevation.

in a solid wood block so as to form two isosceles triangles, the front one being rather higher than that at the rear. Braces and cross-beam are mortised to the four uprights to secure the necessary rigidity.

Other braces, HH′, II′ (Figs. 97 and 98), contribute to the strength of the structure, and at the same time serve to carry different collars and bearings; finally a beam J projects horizontally to a distance of 4ft. 10in. at the rear, so as to receive a prop or stay in case the wind is too strong, or, in any case, to protect the mechanism should the machine be blown over. Up to the present this has not been much required.

The frame of the Windmill.—A cast-iron plate K, 3ft. 3in. in diameter, and $\frac{4}{10}$ inch in thickness, is fixed on the main shaft by a brace and cotter. On the front part of this plate are eight lodgments, to receive eight arms L, $2\frac{3}{10} \times 1\frac{1}{2}$ inches section near the centre, and $2\frac{3}{10} \times \frac{4}{10}$ inches at the circumference. They are fixed in the lodgments by iron braces, bolted at the rear of the plate K. Three rings are braced to these arms M M′ M″, made of angle-iron riveted on flat iron. The first ring M (Fig. 99) forms a cylinder concentric to the shaft O, 6ft. 6in. in diameter, and $5\frac{1}{2}$ inches in height, provided with 32 openings to receive the vanes, the second ring M′ is 13 feet in diameter, the third M″ 19ft. 8in. They are both provided with 32 large notches, the curve of which corresponds to that of the vane which it supports. Fig. 99 shows the shape of these notches. The vanes are secured on the ring M″ by means of an iron pin *ab*, with a handle at *b*, and threaded at *a*, screwing in a brace *c*, by means of which the vane is compressed on the curvature of the notch.

Vanes.—The frame above described carries 32 vanes (four on each arm), made of pine-boards $\frac{3}{10}$ inch thick, 6 inches wide at the centre, and $32\frac{1}{2}$ inches wide at the periphery, forming a vane 11ft. 5in. in length, the small end of which is rounded to help the placing in position.

The vanes, instead of being plane as in other wind-motors, form an helicoidal curve, and as the mill revolves, the wind presses against the surface, less and less inclined towards the centre, where it is almost normal to the plane of the mill. In this way the shock of the wind is reduced in the first part of the curve, and gradually loses its speed to escape in the centre, after having transmitted to the motor all its motive energy.

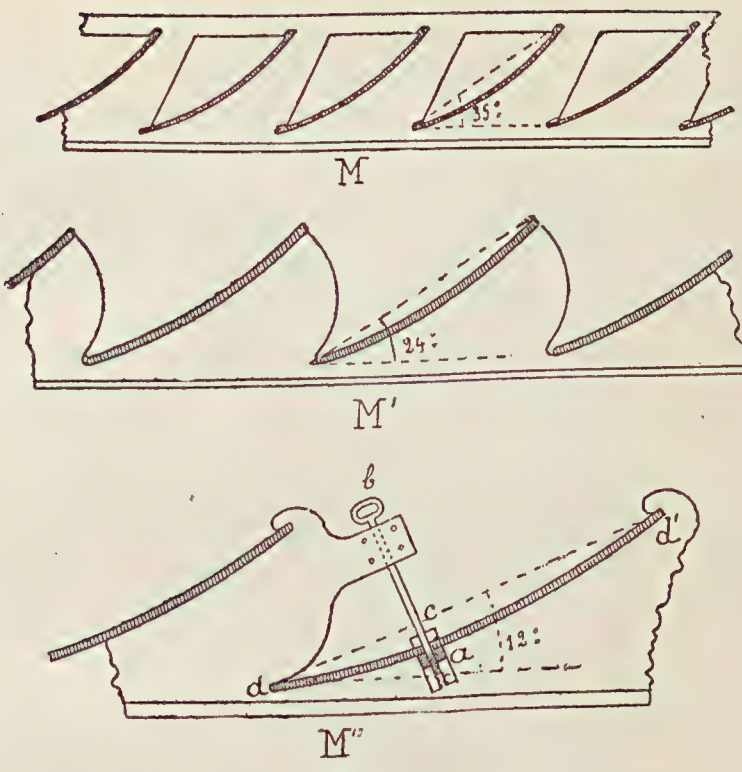

Fig. 99.

As all parts of the vanes do not revolve at the same speed, the chord of the parabolic segment of the section forms an angle of 32° towards the centre, and 12° only towards the periphery, with the plane perpendicular to the axis of the motor.

The curve of the vanes is secured by four pieces of ash-wood $\frac{4}{10} \times 1\frac{1}{2}$ inch section, drawn in the required curve, and nailed under each vane at distances of 3ft. 3in. apart. The part of the vane resting on the circles M M′ M″ is faced with zinc.

The motor is, therefore, a regular polygon, with 32 sides, and a diameter of 26ft. 3in. If the vanes are projected on a plane perpendicular to the axis they overlap each other to the extent of $\frac{4}{10}$ inch only, and in the centre there will be a circular opening 8 inches in diameter. The vanes have also lengthwise a curvature of $1\frac{1}{2}$ inch to utilize the centrifugal force developed by the rotary movement.

The mode of attachment of the vanes allows the sailing area to be regulated according to the strength of the wind, in the ratio 1:16, by removing some of the vanes two by two on the same diameter, so as not to disturb the equilibrium of

the machine. Each vane weighs from 11 to 13 lbs.; one man may fix four per minute, and remove six in the same time, that is to say, that eight minutes are sufficient to fasten all the vanes on, and five minutes only to remove them.

Mechanism.—A shaft O (Fig. 97), $4\frac{3}{10}$ inches in diameter, inclined 5° 40′ from the horizontal, carries the circle of vanes and a pulley P made of ashwood, and revolves through three collars, R R′ R″. The collars R R′ are bolted right down to the foundation iron beam Q, by four long iron rods.

The circular iron plate N, 3ft. 6in. in diameter, is keyed on the shaft O by a conical adjustment, serving as an abutment against the collar R′, forming a very strong and rigid assemblage able to sustain the enormous strain during stoppages. Round the plate N is a steel band, provided with wooden brakes faced with leather, fixed by one end to the frame, and by the other to a lever S (Fig. 98), multiplying the weight of the man by 8, and what is more, the brake acts in the direction of the rotation.

Transmission.—A pulley P, 4ft. 9in. in diameter, keyed on the shaft O, transmits the rotary motion by a crossed belt to another pulley T of the same diameter. The shaft U of the pulley T is parallel to the shaft O, and carries a steel bevel-pinion V, of 7 inches diameter, provided with ten teeth which can be thrown in or out of gear by a lever X with a large cog-wheel Y, keyed on the shaft of the drum Z.

Drum.—The bevel cog-wheel Y is 4ft. 8in. in diameter and carries 44 teeth. The drum is $17\frac{1}{2}$ inches in diameter, 3ft. 3in. with the flanges.

The cable is $\frac{9}{16}$ inch in diameter, 220 to 270 yards in length.

Working.—During the night the vanes of the lower part of the wheel only are left on to prevent it from revolving. Therefore, in the morning four minutes are required to place the sixteen vanes in position again, then the brake being on, the pinion V is thrown into gear with the cog-wheel Y and the brake released; the wheel then starts turning, revolving the drum, which winds the cable at a speed varying between 6 to 14 inches per second, according to the power of the wind. A cable-carrier is placed on the ground 10 feet from the machine, and level with the middle of the drum; the machine goes on working in this manner while the plough is hauled with great smoothness and steadiness. When the plough is close enough to the motor, the speed is decreased by means

of the brake, then the ploughman places a forecarriage in front of the plough, made of two wheels and an axle bent at a right-angle, and, by a kind of tilting movement, as the plough progresses it is lifted out of the furrow (Figs. 20 and 21, pages 40 and 41). Finally, when the plough is completely out of the furrow the drum is thrown out of gear and the motor stopped; the ploughman takes it back with a horse, while the men at the motor shift it sideways a distance equal to the width of the furrow. This is done with an ordinary crowbar if the land is level, and with a screw-jack if it is rising; twelve furrows are opened in this manner, when another pair of rails are placed in front of the wind-mill carriage. This operation is repeated every twelve furrows. Two men are, therefore, necessary for the management of the plant, one for the plough and the horse, and one for the wind-mill. The addition of a second cable and drum revolving at a greater speed to haul the plough back would complicate the machine uselessly, although machines are made with the extra attachments.

The headlands can be easily ploughed, as the cable can haul in any direction, but, in this case, wedges must be placed under the wheels to enable the machine to resist the side strain.

Shifting the motor from one block to another.—When the ploughing of a block is finished, it is easy to shift the motor to another by using it as a self-moving motor. In this case the plough is hauled by the horse in the desired direction, and placed as if about to open a furrow; the drum is then thrown into gear, and, when the cable starts to wind, as the wheels are not wedged, the latter, offering the least resistance, travels towards the plough at a speed of 16 inches per second. It is not necessary to attain a greater speed, as the rails have to be displaced every 20 feet.

Stability.—When the motor hauls the plough in a direction perpendicular to that of the rails, its weight (5 tons 18 cwt. to 6 tons 17 cwt.) suffices to secure the required stability, as the flanges of the rolled joist girders serve, at the same time, as anchors in the ground and blocks against the wheels; when the direction becomes oblique it suffices to block two of the wheels with pegs. It results from calculations made on this machine, that if we assume the motor with all its vanes, and arrested by the brake (the most unfavorable case), the pressure of the wind should attain 85 lbs. per square yard, that is to say, a rate of 59 feet per

second; assuming the vanes normal to the direction of the wind, Hutton's formula, used for inclined surfaces, gives a value rather higher—62 feet to 65 feet, that is to say, a gale.

Orientation.—To change the orientation of the motor, the extremity of the iron girder Q is lifted by a screw-jack, and, under the centre of the beam, two solid wooden blocks with a pivot are placed; four axle arms are placed on the main frame A in a radiating direction, four supplementary wheels are fixed on them, transforming the frame into a kind of turn-table; the orientation is then done by hand as in the case of locomotive engines.

Work.—We give below the figures obtained by the inventor when trenching his property. We are at present unable to authenticate them, but intend to verify them with Prony's mechanical brake. When the rate of the wind does not exceed 20 feet per second all the vanes are left on, and the rate of the cable varies between 4·6 to 7·8 inches per second, the area ploughed is 72 to 120 poles per day, to a depth of $19\frac{1}{2}$ to 24 inches. When the rate of the wind increases, the vanes are gradually removed, so that twelve to fourteen only remain on when the rate of the wind reaches 26 feet, eight to ten when it reaches 32 feet, so that the power obtained does not exceed 7 to 8 B.H.P.

Observations.—The general disposition of the framework, and of the vanes, allow an easy motion of the wheel, although the power obtained is fairly great. This is probably due to the curvature of the vanes, the mechanical yield of which seems to be greater than that of most wind-mills. If we consider the formula generally adopted to represent the motive power of wind-motors:—

$$T = \frac{S \times p \times v^3}{2\,g},$$

T, being the theoretical work the wind is capable of giving;
S, the area of the vanes;
p, the weight of a cubic metre of air, *i.e.*, 1·293 kilos.;
v, the rate of wind in metres per second;
g, the acceleration due to gravitation, *i.e.*, 9·808 metres.

According to the experiments of Smeaton and Coulomb, the mechanical yield would be, for ordinary wind-mills, 45 per cent.; for American wind-mills, 57 per cent. We may admit a yield of 70 per cent. for Lucet's motor on account of the

curvature of the vanes, and the great area of the wheel (59 square yards), and we know that the pressure of the wind increases more rapidly than the surface ; however, further scientific experiments are required to fix the mechanical yield of this machine. The above formula would give for a rate of wind of 4 metres (13ft. 1½in.) per second :—

$$T = \frac{3{\cdot}14\ 16 \times 4^2 \times 1{\cdot}293 \times 4^3 \times 70}{2 \times 9{\cdot}808 \times 100} = 148{\cdot}45,$$

that is to say, 148 kilos (325 lbs.) per second, almost 2 H.P. The following table, calculated by the same formula, shows for different rates of wind the probable power of Lucet's motor, and the corresponding number of fans :—

Rate of the wind in metres per second. (1 metre = 3ft. 3in.)	Available Power.		Number of Vanes.
	Kilogramme metres per second.	H. P.	
3	62·62	0·84	32
4	148·45	1·98	32
4·50	211·36	2·82	32
5	289·94	3·87	32
6	501·01	6·68	32
7	497·25	6·63	20
8	519·57	6·92	14
9	528·55	7·04	10
10	579·87	7·74	8
11	578·86	7·71	6
12	501·01	6·68	4
13	636·99	8·89	4
14	379·80	5·30	2
15	489·27	6·52	2
16	593·79	7·91	2

The management of the motor and its displacement have been well studied, but its orientation is tedious and very defective, as, in the case of the wind not blowing perpendicular to the direction of the headland, that headland becomes triangular, and, in certain cases, might attain half the area of a square block if the wind blows diagonally. This defect might easily be remedied by fixing four rollers under the framework, travelling on a circular rail, carried by four rollers travelling on rolled joist girders in a similar manner to a turn-table. Finally, although the machine is only built for the purpose of trenching or subsoiling, its

inventor has constructed it so that it may be dismounted in three pieces for transit, and provided it with a pulley, allowing the power to be transmitted by belting to any machine.

The motor is working near Carcassonne on an average five days a week, and meteorological observations enable us to foresee that the number of days could be increased during December, January, February, March, and especially April; the winds are less frequent during the rest of the year.

APPENDIX.

COMPARATIVE METRIC AND BRITISH LAND MEASURES.

—	Exactly.	Roughly.
Hectare	2·471 acres ...	Nearly two and a half acres.
Are	3·954 poles ...	Nearly four poles or $\frac{1}{40}$ acre.
Centiare (square metre)	1·196 sq. yds.	Nearly one and one-fifth sq. yds.

HECTARES = ACRES.

Hectares	=	Acres	Hectares	=	Acres	Hectares	=	Acres
1	=	$2\frac{1}{2}$	7	=	$17\frac{1}{4}$	40	=	99
2	=	5	8	=	$19\frac{3}{4}$	50	=	$123\frac{1}{2}$
3	=	$7\frac{1}{2}$	9	=	$22\frac{1}{4}$	60	=	$148\frac{1}{4}$
4	=	10	10	=	$24\frac{3}{4}$	70	=	173
5	=	$12\frac{1}{3}$	20	=	$49\frac{1}{2}$	80	=	$197\frac{3}{4}$
6	=	$14\frac{3}{4}$	30	=	74	100	=	247

ACRES = HECTARES.

Acres	=	Hectares	Acres	=	Hectares	Acres	=	Hectares
1	=	0·40	7	=	2·83	40	=	16·19
2	=	0·81	8	=	3·24	50	=	20·23
3	=	1·21	9	=	3·64	60	=	24·28
4	=	1·62	10	=	4·05	70	=	28·33
5	=	2·02	20	=	8·09	80	=	32·37
6	=	2·43	30	=	12·14	100	=	40·47

BRITISH LAND MEASURES.

1 Acre = 4 Roods = 160 Poles = 4,840 Square Yards.
1 Rood = 40 " = 1,210 "
1 Pole = $30\frac{1}{4}$ "

LAND MEASURES USED IN DIFFERENT COUNTRIES.

—	—	Contents of a Single Measure of each Sort.		Number of each equal to 10 English Acres.
		English Square Yards	French Acres.	
England and Australia	Acre	4840	40·466	10·000
Scotland ...	Acre	6150	51·419	7·869
Ireland ...	Acre	7840	65·549	6·173
France ...	Hectare	11960	100·000	4·046
Berlin	Great Morgen ...	6786	56·736	7·132
	Little Morgen ...	3054	25·534	15·848
Prussia ...	Morgen	3053	25·526	15·853
Saxony ...	Acre	6590	55·098	7·344
Hamburg	Scheffel of Corn Land	5022	41·984	9·637
	Morgen	11545	96·525	4·192
Hanover ...	Morgen	3100	25·918	15·613
Nuremberg	Corn Land Morgen	5654	47·272	8·560
	Meadow Morgen ...	2544	21·270	19·025
Rhineland ...	Morgen	10185	85·158	4·752
Dantzic ...	Morgen	6650	55·642	7·278
Geneva ...	Arpent	6179	51·661	7·833
Amsterdam ...	Morgen	9722	81·286	4·978
Netherlands ...	Vierkantebunder ...	119·6	1·000	406·722
Naples ...	Moggia	3998	33·426	12·106
Spain ...	Fanegada ...	5500	45·984	8·800
Portugal ...	Geira	6970	58·275	6·944
Sweden ...	Tunneland ...	5900	49·329	8·203
Switzerland ...	Faux	7855	65·674	6·161
Tuscany ...	Quadrato ...	4074	34·062	11·880

ILLUSTRATIONS.

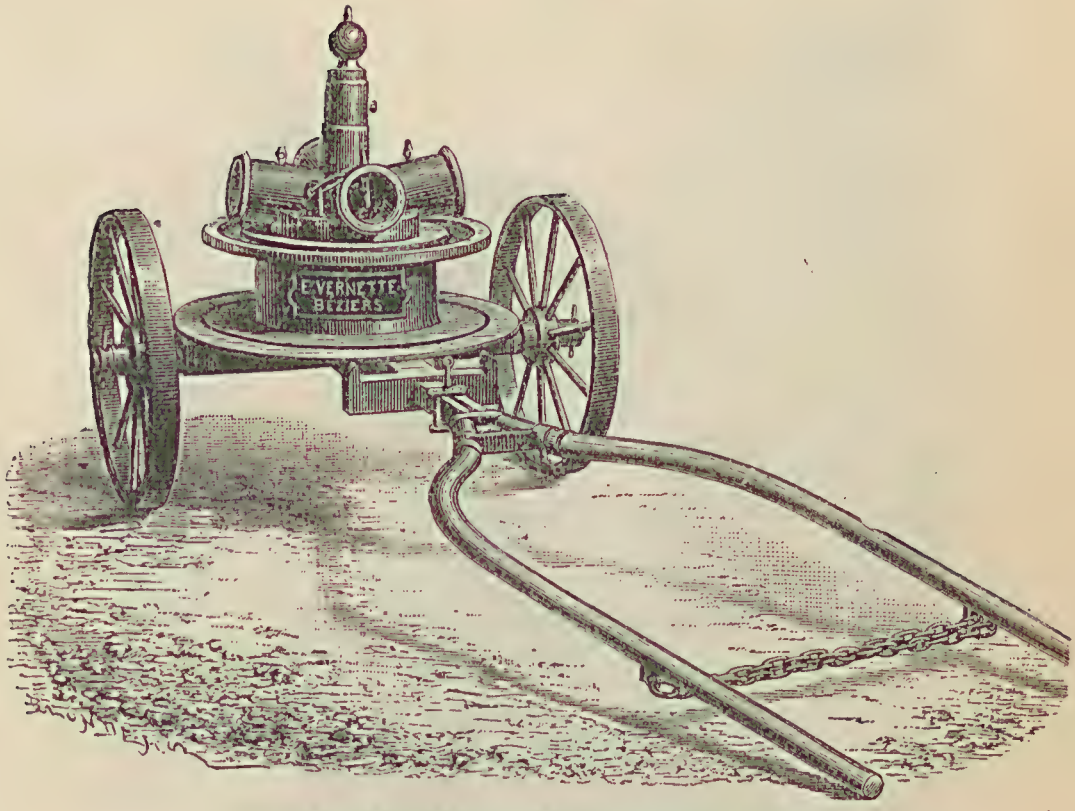

Fig. 100.—Vernette's Small Capstan, mounted on wheels.

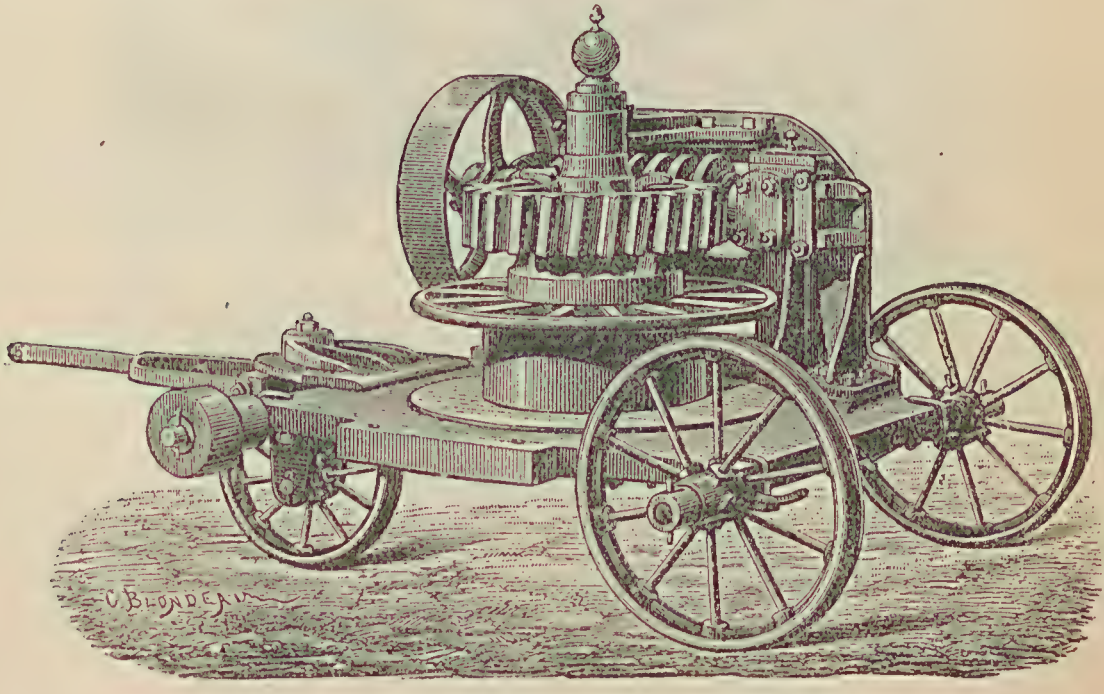

Fig. 101.—Vernette's Steam Winding Drum, with endless screw.

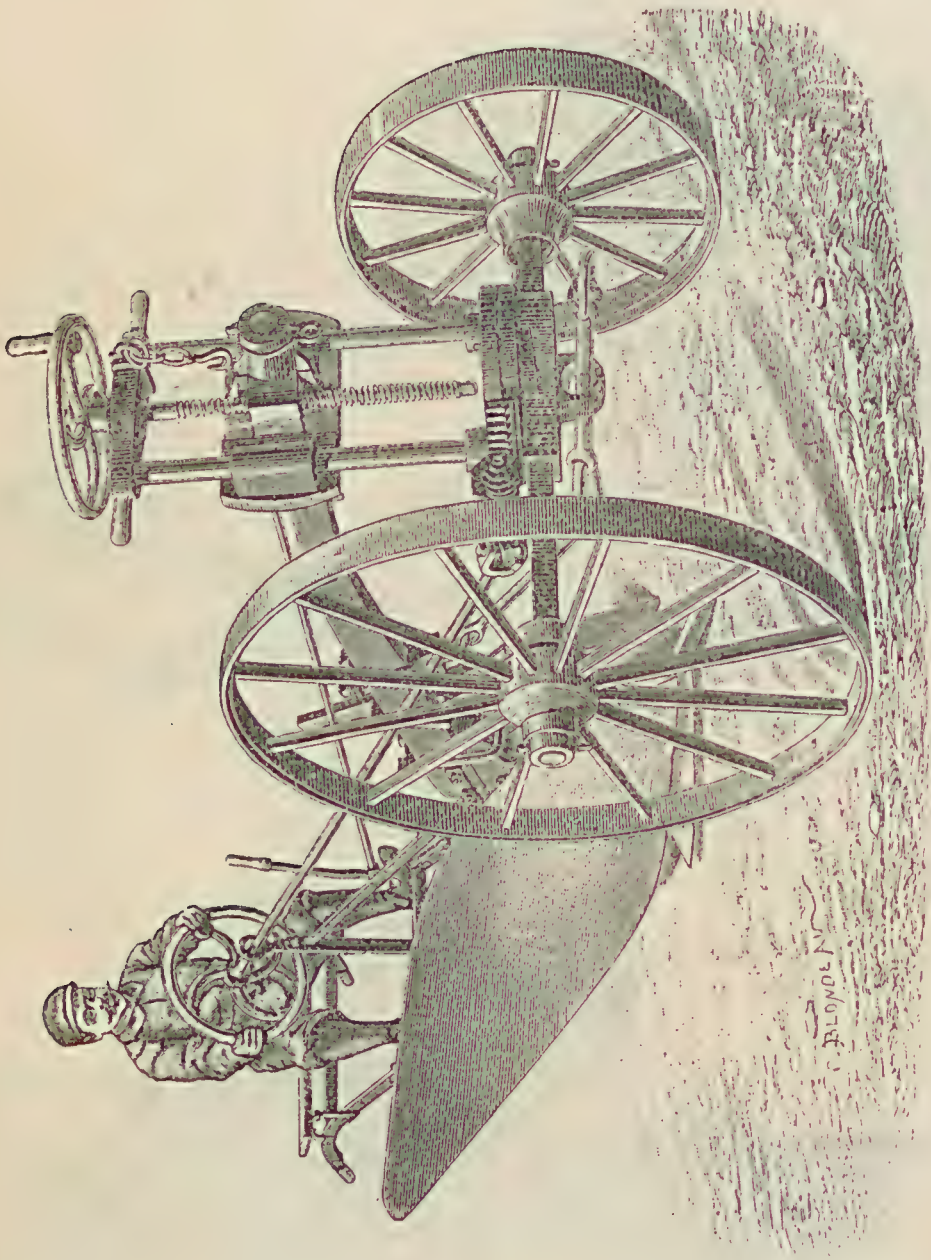

Fig. 102.—Vernette's Steam Plough, with seat.

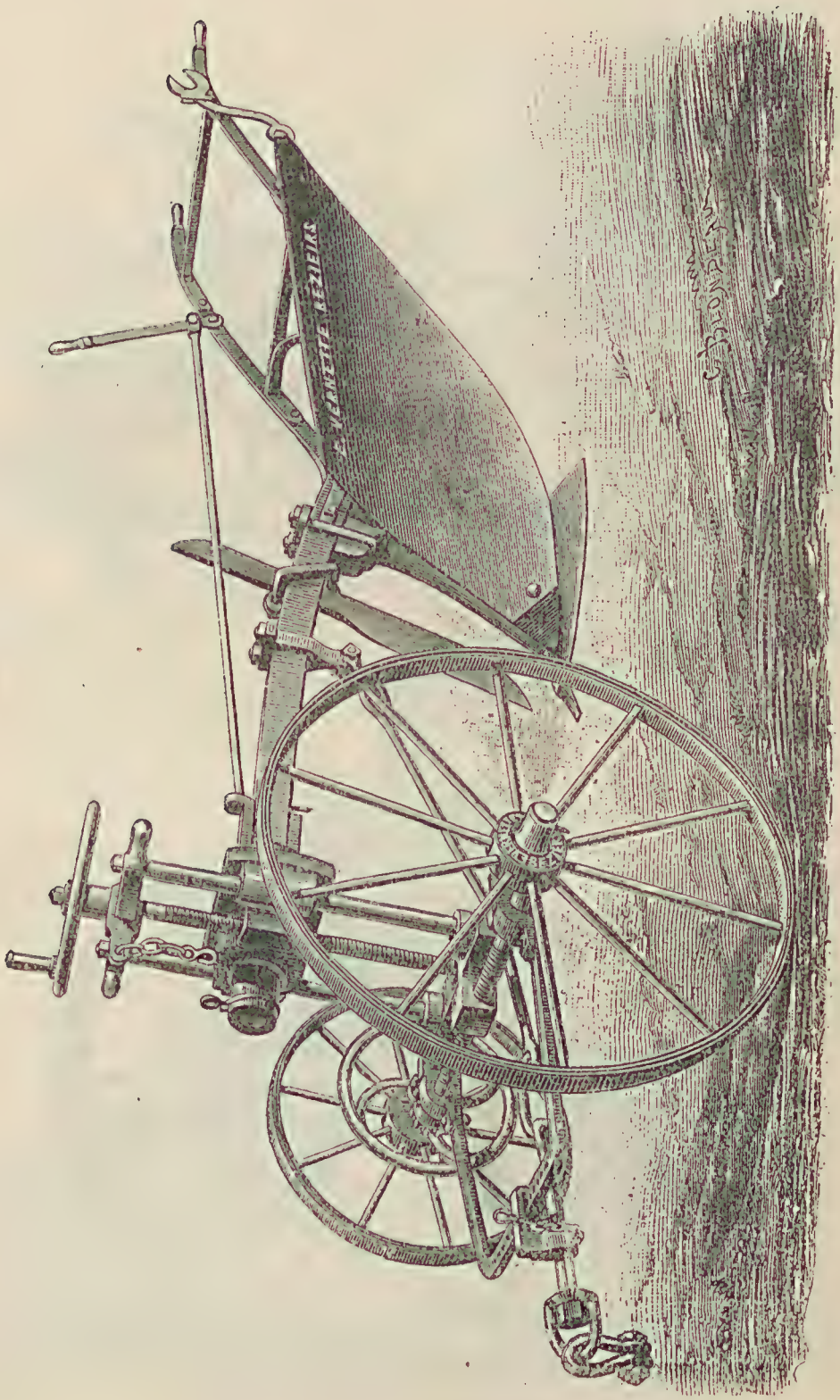

Fig. 103.—Vernette's Large Trenching Plough.

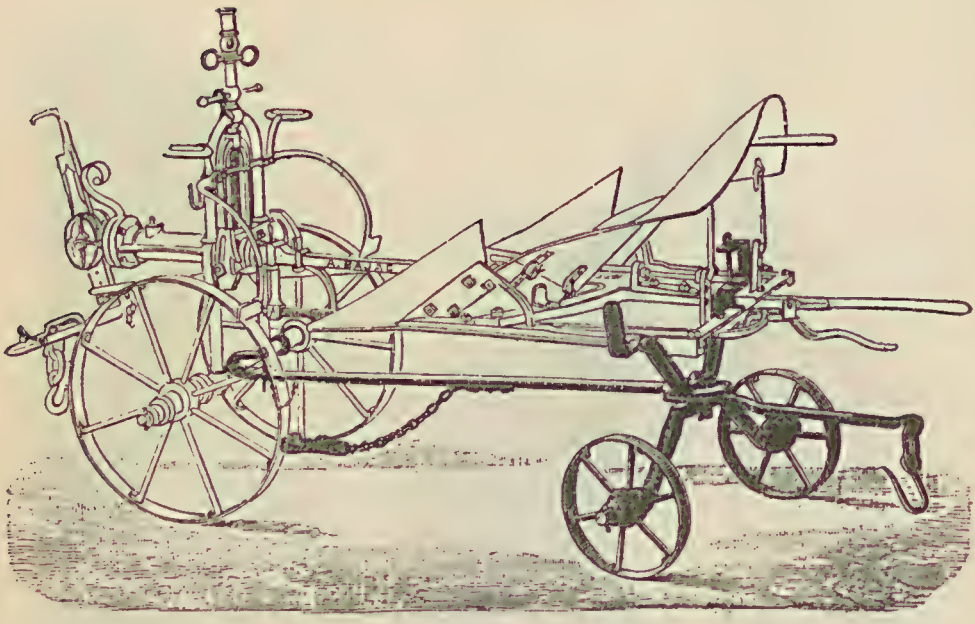

Fig. 104.—Turn-Wrest Plough, mounted on patent carrier for transit.

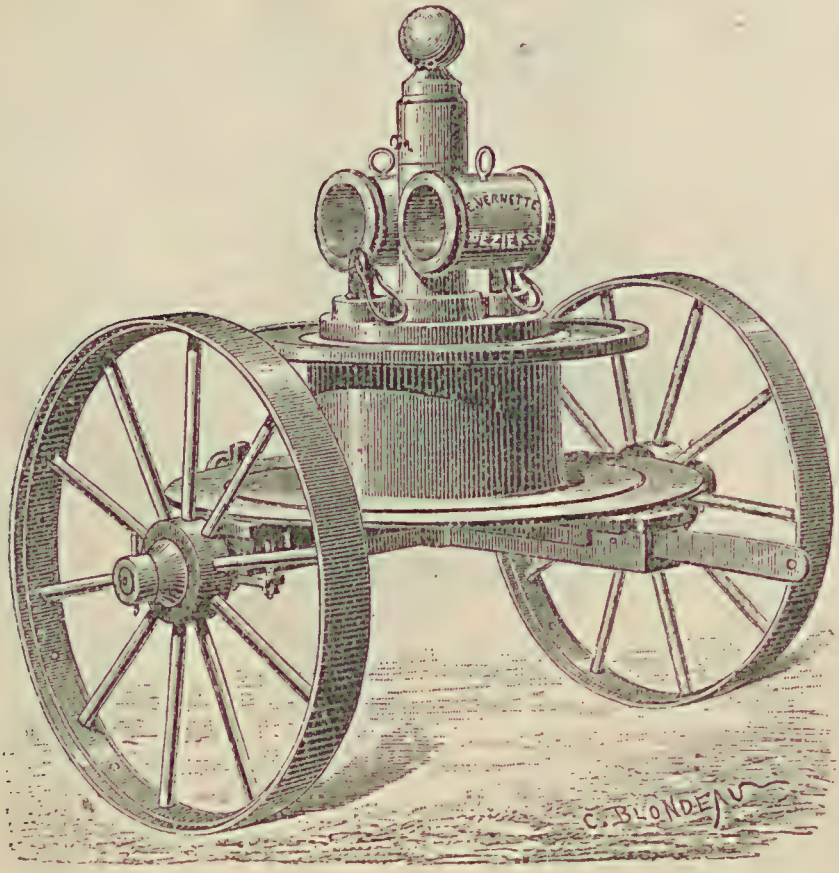

Fig. 105.—Vernette's Capstan. Pattern 1892.

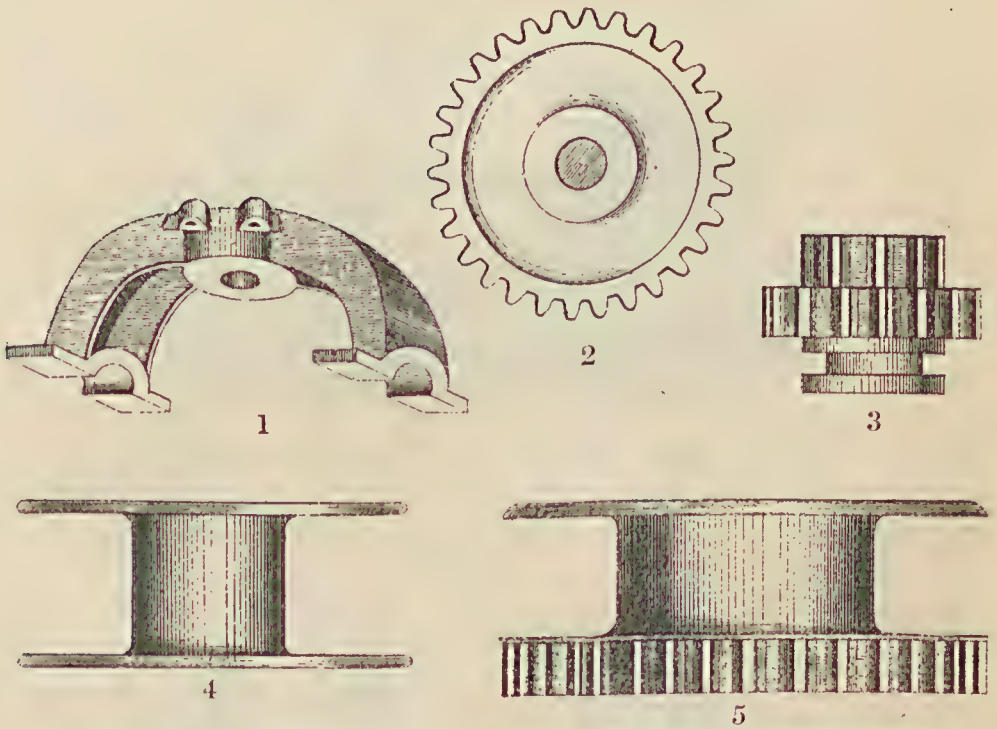

Fig. 106.—Guyot's Horse-Gin. 1. Bridge; 2. Large Cog-Wheel; 3. Coupling Clutch; 4. Small Drum; 5. Large Drum.

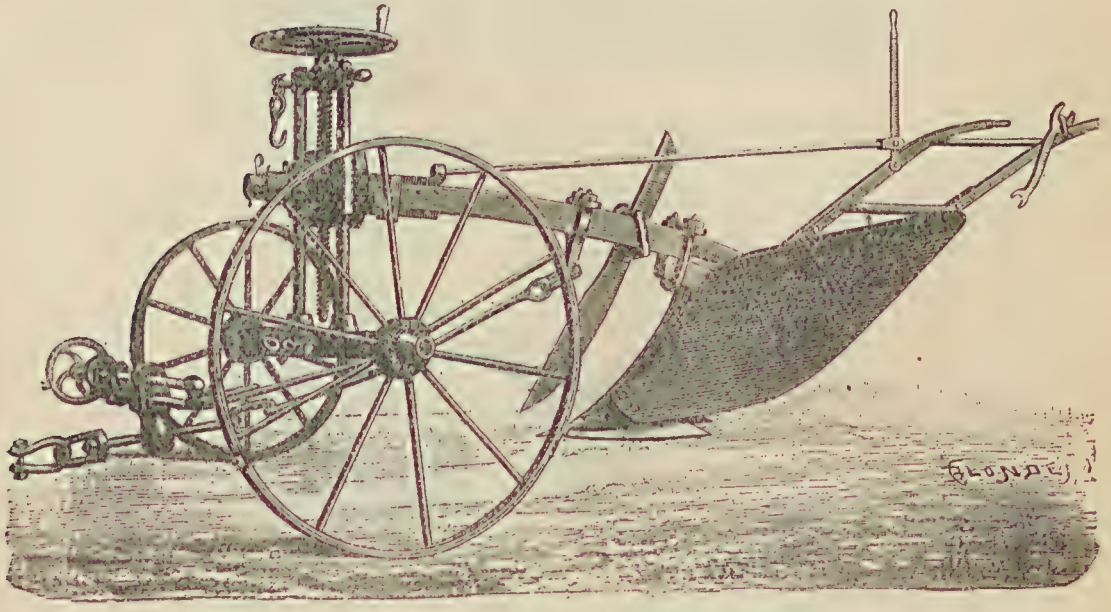

Fig. 107.—Vernette's Trenching Plough. Pattern 1891.

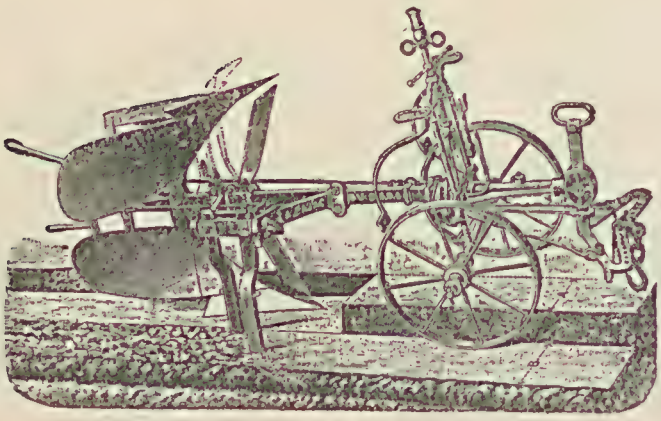

Fig. 108.—Bajac's Turn-Wrest Plough, with subsoiling tines on the side.

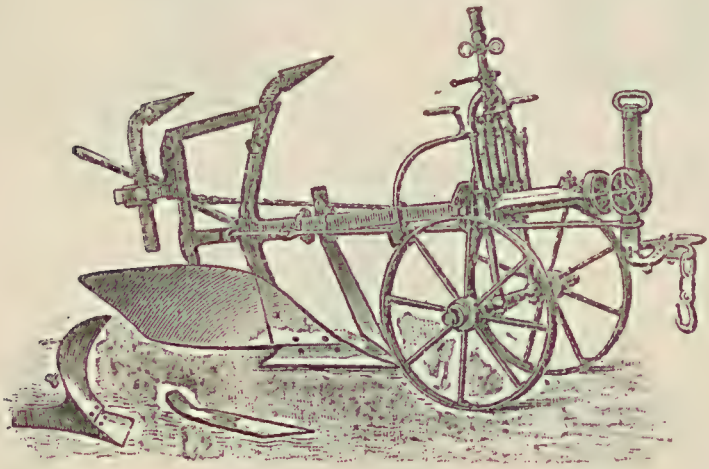

Fig. 109.—Bajac's Turn-Wrest Plough, transformed for subsoiling.

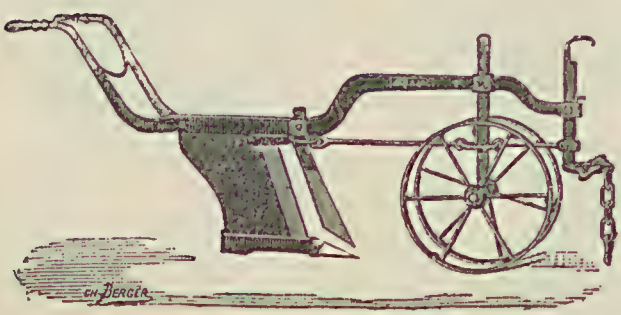

Fig. 110.—Bajac's Subsoiler, used to cut roots.

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